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Survey on Priority Based Schemes Used For Data Dissemination in Wireless Body Area Network

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Abstract— Signals generated by human body can be divided into two classes based on their significance to the life: critical signals or emergency signals and non-critical signals or normal signals. The critical real-time messages (RTMS) or vital signs should be transmitted within the time limit and they must be collision free. On the other hand, the noncritical signs or non-real-time messages (NRTMS) are required to be delivered with the best effort. In wireless body area networks (WBAN's) sensing various types of data needs accuracy as it is critical to human life, in order to achieve exact diagnoses data should be transmitted in reliable and real-time manner. To save precious life various protocols are designed in which data having high priority is transmitted first.

In some protocols priority is assigned to nodes. Assigning priority includes number of parameters for example type of data i.e. Emergency or normal and backoff period .In this paper protocols that provide reliable and collision free transmission by allocating channel on the priority basis are discussed. Outcome of some of the papers has been reviewed in this paper as large numbers of journals and research papers have been published regarding priority based access techniques used in wireless networks.

Keywords—priority, WBAN, backoff period, reliable, collision.

I. INTRODUCTION

In the initial stages of wireless communication networks, main focus is on achieving the large area for communication. After fulfilling this requirement, more attention is paid towards improving the quality of connection. Short-range wireless is expected to play a crucial role in providing the best connected scenario for anybody to anything from anywhere at any time. The emerging Wireless Body Area Networks (WBAN) is meant to support both medical and non-medical consumer electronics (CE) applications. Different service requirements are presented by these two types of applications. It has become a new challenge for WBAN to satisfy both medical and CE applications with uniform protocols. WBAN is developed to provide the "last meter" connection. Following WPAN, WBAN becomes hot topic with the increasing attention paid to medical application. The studies and discussion on WBAN speed up the procedure in standardization. Typical communication distance in WBAN is restricted to be within 3 m of the body area. IEEE launches a new task group of IEEE 802.15.6 called as WBAN [1].This standard support both medical and CE applications. Both applications have significant differences in term of data-rate, reliability requirement, traffic arrival and access latency. To meet the requirements of different applications, narrowband physical layer (PHY) and ultra band (UWB) PHY are both proposed on PHY interfaces in WBAN. Body area network (BAN) is also known as wireless body area security network (WBASN). BAN is a wireless communication between several nodes implanted on or in a human body.

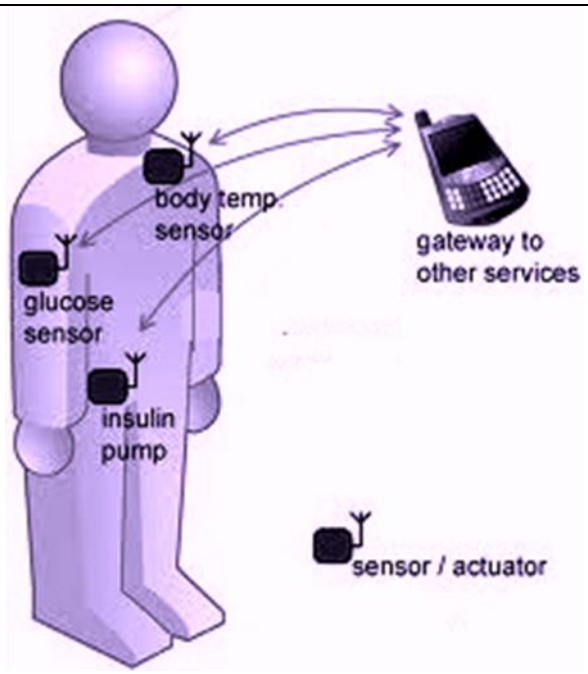

Figure.1 Architecture of WBAN

Number of nodes in a network may range from one to dozens of nodes. Nodes implanted on the body communicate with the outside world through a coordinator node. Figure.1 shows the architecture of WBAN in which different devices sense specific signals and then transmit to the master node or coordinator.

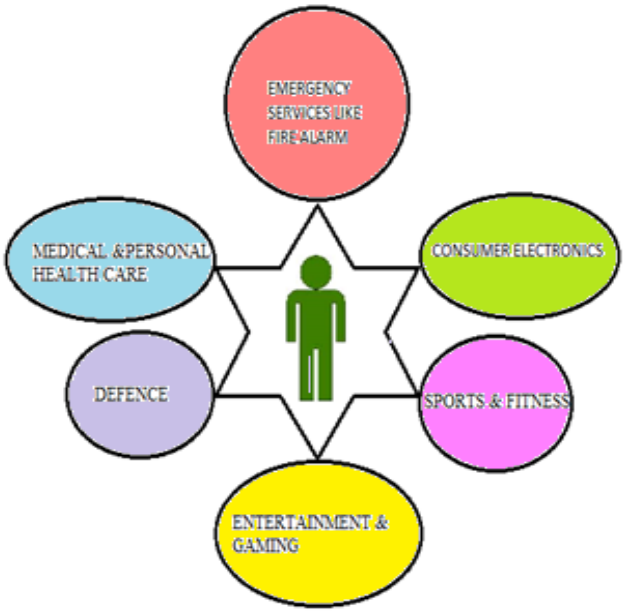

Figure.2 Applications of WBAN

These nodes continuously monitor patients' critical information for further diagnosis. On body nodes can be used either for medical purpose or for gaming applications. All these nodes can be arranged in different topologies such as mesh, tree and star topologies. Most commonly used topology is star topology in which all the nodes are connected to one central node known as coordinator.

WBAN provide interfaces for administration of drugs in hospitals, rehabilitation aids, for diagnostics and for remote monitoring of physiological data. Its applications in the field of defense are vast which include monitoring of health, location, temperature and humidity levels. These results are helpful for increasing performance of soldiers and provide alerts to cope with natural calamities. In sports it is very helpful as it collects athlete's complete data. Complete record of athlete's health makes it easy for mentors to catch up his weakness. It monitors athlete's health very closely. Figure.2 shows WBAN applications. Main requirements of WBAN are data authentication, data confidentiality, data freshness, secure data management, data integrity and availability. Data authentication is essential for each node to verify that the data is transmitted by an authenticated node. Data confidentiality is needed to protect from any false disclosure, data freshness make it sure that the data frames are in sequence and unused.

Data management is required at coordinator node since it ensures key distribution to the nodes in order to achieve encryption and decryption process. Data integrity protects the data from tampering on the way to coordinator. Availability ensures that the detailed information of patient is always made available to the doctor.

II. REVIEWS

A. Priority-Guaranteed Mac Protocol For Emerging WBAN's (PG-MAC)[2] :

IEEE 802.15.4 MAC protocol can work either in beacon enabled mode or non beacon enabled mode. To achieve reliable MAC control beacon enabled mode is enabled. Figure.3 shows superframe structure of IEEE 802.15.4. A superframe contains an active and inactive portion. The inactive part is used for low rate and low-rate considerations. The active part is further divided into three parts: a beacon, contention access period (CAP), and contention free period (CFP). Carrier sense multiple access with collision avoidance (CSMA/CA) is employed by the nodes in CAP to access the channel. The CFP is divided into guarantee time slots (GTS), TDMA approach is used by nodes in this portion. Several limitations of this protocol are revealed, when used in WBAN scenario. First one is, due to the low SNR carrier sensing is not reliable in UWB PHY.

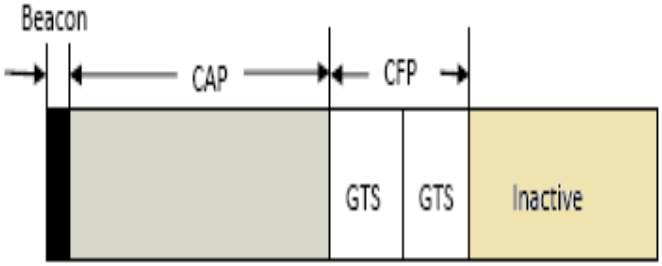

Figure.3 IEEE 802.15.4 Superframe Structure

The "hidden Terminal problem" will rise in IEEE 802.15.4 due to the use of CSMA-based random access control. Second limitation is the presence of only one common contention based access period, the CAP part, which deprives the priority of life critical medical applications. Some schemes are proposed that uses parameter-based priority control.

Regardless of this, soft control cannot guarantee the priority of the medical applications because some self centered nodes can always use short contention window and back-off delay without being noticed by the master node. Third limitation is that this protocol does not consider the energy efficiency of the master node. The limitations of applying IEEE 802.15.4a and IEEE 802.15.4b MAC to WBAN is evaluated in [4].

PG-MAC protocol adopted a dedicated control channel to implement random access contention with small control packets. Schedule based data channel is used to protect data packets from collision. To provide priority differentiation, control channel is further divided into application specific sub-channels. Division of one superframe is as follows:

- ***a.*** ***Beacon:*** Used for control and down link synchronization.
- ***b.*** ***Control channel AC1:*** It is used for the uplink control of priority medical traffic.
- ***c.*** ***Control channel AC2:*** This channel is used for uplink control of CE and other traffic.
- ***d.*** ***Data channel TSRP:*** Timeslot is reserved for periodic traffic.
- ***e.*** ***Data channel TSRB:*** Time slot is reserved for bursty traffic.

Format of PG-MAC superframe is drawn in Fig.4 .The random access mechanism on the two control channels, AC1 and AC2, recourse to randomize slotted ALOHA. The node randomly selects one timeslot to send the link request. With the division of control channel, the access contention of the medical traffic is protected from the busier CE traffic. Separated AC1 channel is used by the nodes having medical data to send request for resources. All these requests are triggered only at the beginning of a new monitoring period and hence occur at low frequency. In the same way CE applications request for resources on the AC2 channel.

Depending on the nature of the traffic, the CE node will send request to reserve the resource for a certain period for video or audio streaming or send request for bursty traffic on a per session basis.

For ease we assume that all the medical applications have higher priority than other applications. On receiving the resource request on the control channels, the allocation of resources is done handled by the master node in centralized manner. This protocol provides different quality of services (QoS) to different applications as the master node is aware of the application category. On demand TDMA scheduling is applied to allocate two data channels TSRP and TSRB. TSRP channel allocates resource to periodic traffic while TSRB assign the resource to bursty traffic. Hence the arrangement of the two data channels is determined by the type of traffic, periodic or bursty. In this protocol the CFP part is divided into two sub parts, CFP1 and CFP2. The benefit of this format is that the resources allocated to the nodes that handle periodic traffic remains intact when the length of the control channel is changed. The main difference between the PG-MAC and the IEEE 802.15.4 MAC can be summarized as follows: in PG-MAC, dedicated control channel is used to make the data channels free from collision. Control channels are divided into application specific sub channels, and hence the access contention is restricted to the same application category. To improve resource efficiency on the control channels, randomized slotted ALOHA is used instead of CSMA-CA.

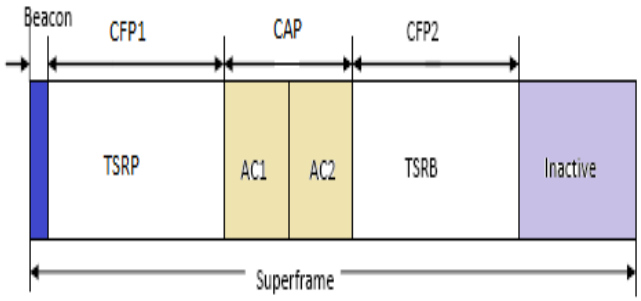

Figure.4 Superframe Structure Of PG-MAC Protocol.

This protocol achieve scalability, improve the energy efficiency, Idle listening of the master node is minimized, the access rate does not change with the increase in user amount, collision among access requests is reduced for priority traffic.

B. Priority-based CCA periods for efficient and reliable communications in WSN's protocol [5]:

CSMA-CA is utilized by the MAC layer of IEEE 802.15.4 to control node's medium access. In CSMA-CA all node's has to follow the Binary Exponent Backoff (BEB) algorithm to affirm that the medium is free from ongoing transmissions before beginning its packet transmission. BEB doesn't take any measures to guarantee the priority of access among the nodes, although it is effective in reducing the traffic. This protocol is modified that can adaptively prioritize the access to the medium such that all nodes are treated fairly. The superframe contains a mandatory active period and an optional inactive period.

Active period is divided into CAP and optional CFP, both are shown in Figure.4. During CAP, the nodes follow slotted CSMA-CA mechanism to access the medium. That is accessing the medium is ruled by the BEB algorithm. According to this algorithm, whenever a node has a packet ready for transmission, it should backoff for a period of time, the backoff period is randomly selected from the interval [0, 2^{BE}-1], where BE is backoff exponent that has a default minimum value (macMinBE) of 3 and has default maximum value of 5 (macMaxBE) [3]. When the backoff period is expired, the node is required to conduct two clear channel assessments (CAA's). The transmission of the packet cannot be started until the medium is found idle during both CCA's. The node should backoff again if any one of the two CCA finds the channel busy.

a. Priority-Based BEB Algorithm:

IEEE 802.15.4[6] recognizes two classes of priority. First class is given to the data packets and second class is given to their associated ACK packets. CCA1 is needed to avoid collision with an ongoing data packet transmission. After the CCA1 runs, CCA2 is imposed such that the acknowledgement (ACK) for that packet is transferred successfully. Transparency among the nodes is maintained by giving higher priority to the nodes that experience repeated access failures. Greater the number of attempts made by a node to access the medium, higher will be the priority of that node. Backoff period will also determine the priority of nodes, higher the priority of frame, shorter will be the backoff period. This protocol tackles the problem of prioritizing the CSMA-CA procedure in IEEE 802.15.4 standard.

CSMA-CA uses the BEB algorithm to manage the contention among all the nodes trying to access the wireless medium. The basic problem with BEB algorithm is that it treats all nodes in the network equally, without giving any consideration to the repeated transmission failures or channel access failures experienced by some nodes. Priority-based BEB (PB-BEB) is designed to overcome this problem. In PB-BEB, the number of CCA's is controlled probabilistically according to the level of collision over the communication medium. PB-BEB shows superior performance over BEB, in terms of reliability, channel utilization, power wasted in collision, and channel collision time.

C. Priority Based Adaptive Timeslot Allocation Scheme For Wireless Body Area Network[7]:

In this protocol**,** Data traffic is divided into 3 priority classes, CAP is categorizes into 3 access phases. Collision probability and final throughput are influenced by the performance of CAP. CAP is divided into 3 sub-phases: phase-1, phase-2, and phase-3. C_1 represents first class priority, C_2 represents second class priority and C_3 represents third priority class. Second priority class is further sub divided into C_{22}: Continuous medical data in second class and C_{23}: Discontinuous medical data in second class. Nodes that transmit C_1 data can access the channel through phase-1, phase-2, and phase-3. Nodes that transmit C_2 data can access channel through phase-2 and phase-3.

Nodes having lowest priority i.e. nodes transmitting C_3 data can only use phase-3 to access the medium. It means that phase-1 can be only used for transmitting emergency data, phase-2 can be used to transmit emergency as well as medical data and phase-3 can be used by all types of data for transmission. Priority based adaptive timeslot allocation scheme (PTA) scheme is inspired by aiming to design a MAC protocol, that support various QoS requirements of wireless body area networks. It provides better QoS for the

data having higher priority, its performance is better in terms of energy consumption efficiency and average transmission.

D. A novel priority-based channel access algorithm for contention-based MAC protocol in WBANs [8]:

This paper proposed a novel channel access algorithm for contention based MAC protocol. To solve the contention complexity problem this algorithm is devised precisely. The algorithm proposed in this protocol classifies the contention based access phase into sub-period by calculated offset. This algorithm categorized packet into 4 levels, divides cap into sub-phases on the basis of threshold, offset is calculated to decide the length of the divided sub-phases and defines the delay threshold for each level of packet. By considering the above four ideas, power consumption is reduced and it diffuse contention complexity also. The future work of this protocol is, by using probabilistic analysis method the optimization of calculating offset is done.

III. CONCLUSION

This paper presents review of papers that laid stress on the priority-based data dissemination in a network. Research work done by various protocols is discussed in this paper. Positive outcomes are appreciated and undesirable outcomes become base of the future work. Features like Scalability, Energy efficiency, reliability, and collision avoidance are achieved in these protocols. By using the concept of priority in various ways, communication within a network has become more economical and successful.

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