Scheduling and Resource Allocation for Coexisting WBANs

Emy Mariam George, Lillykutty Jacob
Department of Electronics & Communication Engineering
National Institute of Technology Calicut, 673601
Email: emy_p160047ec@nitc.ac.in, lilly@nitc.ac.in

I. Introduction

The increase in life expectancy and health care cost have triggered the humans in their quest for more affordable and proactive health care systems. One of the successfully emerged solutions is the wireless body area network (WBAN) which can provide continuous health monitoring and real time feedback to user or medical personnel without hindering the users lifestyle. The perseverant interests in this area have led to the development of the communication standard for WBAN, IEEE 802.15.6, in 2012. The standard requires upto 10 coexisting WBANs to function properly in a 6 m^3 volume.

II. Motivation and Problem statement

The data collection and transmission scheduling for a single WBAN is mentioned in the standard in detail. However, when two or more users wearing WBANs are in close proximity the inter-user interference between the WBANs cannot be ignored, especially if they are using the same channel for transmission. But IEEE 802.15.6 fails to specify any access coordination between the WBANs at the MAC sublayer. This could lead to severe co-channel interference among the coexisting WBANs. This inter-network interference will raise the signal to interference plus noise ratio (SINR) and can result in throughput degradation and packet loss. Packet loss is a threat to patients lives when WBANs are used in the healthcare sector. This will also lead to energy wastage and decrease in energy efficiency of WBAN nodes.

The problems with coexisting WBANs can occur for the following reasons. Even though WBANs have a short communication range, the high density of WBANs in places like nursing homes, hospitals could result in packet collision if they are left unscheduled. Another reason is the limited wireless resources. Most WBAN use the 2.4 GHz ISM band which is also shared with Wi-Fi, Bluetooth and Zigbee networks. Thus there are insufficient collision-free channel resources to satisfy the demand. Also, the random mobility of WBAN change the inter-WBAN topology and cause problems with inter-WBAN coexistence. Thus along with limited channel resources, the mobility, density and the distributed nature of each WBAN will also make the interference mitigation in WBAN a more challenging problem.The popular power control games adopted in cellular network becomes less effective due to low power consumption and group based node structure of WBAN. Also schemes developed for static and low mobility scenarios in wireless sensor network (WSN) could also be considered unsuitable for WBANs.Most of the existing proposals for interference mitigation in other networks fail to become a solution due to the dense deployment of nodes, frequent topology changes in the network, and the high mobility of the WBANs.

III. Proposed Solutions

Some of the optional mechanisms in the standard for interference mitigation between coexisting WBAN are beacon shifting, channel hopping and active superframe interleaving. It is seen that channel hopping is the most effective coexistence scheme for dense WBAN environment. The channel hopping in IEEE 802.15.6 is entirely based on the channel hopping sequence and the channel separator field whose default value is 2. It fails to consider the coexisting environment in its hopping approach. For a dense network of WBANs operating with less number of frequency channels, even adopting different channel hopping sequence or channel separator field can result in channel conflicts; and thus not improving the coexistence capability of the WBANs.

In our preliminary work we considered a probabilistic channel hopping mechanism to improve the network utility for a dense network of WBANs by allocating a channel with least interference as the transmission channel by monitoring the experienced interference in each hop interval. But the energy and delay involved in the channel sensing makes it unsuitable for the WBAN applications.So we consider this channel selection problem as a finite repeated potential game with distributed stateless Q-learning algorithm.Numerical results shows that the convergence of the learning algorithm helps to achieve the Nash equilibrium point of the game. This is because the proposed algorithm significantly improves the network utility by updating its Q values for each action when compared to the existing random hopping approach specified in the IEEE 802.15.6 standard.

IV. References

1) IEEE standard for local and metropolitan area networks-part 15.6: Wireless Body Area Networks, pp.1-271,2012.
2) J.Wang,Y.Xu, A.Anpalagan and Zhan Gao,"Optimal distributed interference avoidance: potential game and learning", *Transactions on Emerging Telecommunication Technologies*,vol.23,pp.317-326,2012.