IJSTA

International Journal of Scientific and Technical Advancements

Review Paper on IEEE 802.11b and Bluetooth Interference: Co-existence and Simulation

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Abstract – The advancements in the wireless networks provide realistic distant communication in different areas of the world. This paper deals with the simulation of Bluetooth and Wi-Fi systems coexistence. The emergence of several radio technologies such as Bluetooth, and IEEE 802.11 operating in the 2.4 GHz unlicensed ISM frequency band may lead to signal interference and result in significant performance degradation, when devices are co-located in the same environment. Both Wi-Fi and Bluetooth operate on ISM (Industrial, Scientific and Medical) unlicensed radio frequency (RF) spread spectrum from 2.4GHz to 2.4835GHz. Early Bluetooth devices interfered with 802.11b because both techniques use same channel for an extended period of time which causes interference, data lost, and eventually loss of services of both technologies. Particularly this interference greatly effects SCO voice link which is main issue of interference due to collision. In this paper SCORT technique is suggested to improve the performance of collocated Bluetooth and Wi-Fi systems. In addition, this paper presents a new Bluetooth voice packet Synchronous Connection Oriented with Repeated Transmission scheme to minimizing the interference between Bluetooth and 802.11 wireless networks. For the sake of experimental verifications, MATLAB toolbox will be used for simulation.

keywords – Bluetooth, Wi-Fi, interference, SCO, SCORT.

I. INTRODUCTION

At present time, wireless access networks use different technologies. The most extended wireless technology for access to Local Area Networks (LAN) is standard 802.11b, which is known all over the world as Wi-Fi standard (Wireless Fidelity). It allows closely located devices to share data. In modern era, Radio technologies are considered by WPAN and WLAN. Both technologies operated on popular and unlicensed 2.4 GHz ISM (Industrial, Scientific and Medical) frequency band. WLAN devices operating in proximity to WPAN devices have significant impact of the interference on the performance of WPAN and vice versa. On the other hand, Personal Area Networks (PAN) is very much-used Bluetooth standard, which is low-cost, low-power, secure and robust technology providing connection up to 10 meters of range.

The transmission range of Bluetooth is 10 meters and 802.11b have 100 meters. The wider ranges of WLAN also cover up the Bluetooth range and interfere with Bluetooth transmission. If two or more WLAN devices using different channels exist in same area then the 2.4 GHz ISM band is fully occupied , making the Bluetooth FHSS system infeasible and increases BER in data output. It is anticipated that some interference will result from all these technologies operating in the same environment. WLAN devices operating in the proximity to WPAN devices may significantly impact the performance of WPAN and vice-versa.

Though there are many techniques which have been used for the reduction of the interference between Bluetooth and Wi-Fi but all the techniques suffer from one disadvantage or the other. In this paper, a comparative analysis based on different parameters like bit error rate, forward error correction, collisions etc. have been planned. In addition, we will discuss our findings on the performance of these systems when operating in close proximity to each other.

II. VARIOUS METHODS TO REDUCE INTERFERENCE

The various available techniques to reduce the interference between Bluetooth and Wi-Fi are discussed below:

A. BSIM

BSIM stands for BLUETOOTH SCO LINK INTERFERENCE MITIGATION**.** It is applied to the Bluetooth specification version 1.1 and before. It uses non collaborative mechanism. It can avert an overlap between Bluetooth and WLAN packets and maintains the quality of Bluetooth SCO link when the number of WLAN channels is large while only slightly lowering WLAN's data throughout. But this technique could not be used on higher Bluetooth specification versions.

B. AWMA

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AWMA stands for ALTERNATING WIRELESS MEDIUM ACCESS. It is based on the time-division multiple access scheme. It assumes that the 802.11 access point and the Bluetooth master are collocated in the same physical unit and the 802.11 and Bluetooth devices transmit alternatively to avoid overlap in time between their transmissions. It subdivides the interval into two subintervals, one for WLAN traffic and other for Bluetooth traffic. It thus prevents mutual interference by exploiting alternate transmissions. But AWMA cannot be applied in the case of Bluetooth SCO link. Therefore this technique was discarded.

C. OLA

OLA stands for OVERLAP AVOIDANCE. OLA schemes are based on simple traffic scheduling techniques. These schemes do not need a centralised traffic scheduler. They can be implemented in collaborative and non- collaborative mode. They are able to mitigate interference between collocated and non- collocated Bluetooth and IEEE802.11 devices. They have a minor impact on IEEE802.11 standards and on Bluetooth specifications. Hence the significant reduction can be achieved in interference. These schemes are based on the assumptions that 802.11 and Bluetooth can detect interference due to other technologies sharing the same environment. But this assumption holds true in a collaborative setting where information related to traffic transmission can be directly exchanged between the interfering systems.

D. E-BSIM

E-BSIM stands for ENHANCED BLUETOOTH SCO INTERFERENCE MITIGATION.As in BSIM (Bluetooth SCO Interference Mitigation), a WLAN packet, whose frequency overlaps with Bluetooth SCO packet is postponed, possibly degrading the WLANs performance. This disadvantage of BSIM is overcome in E-BSIM. In this mechanism, Bluetooth slots are classified as good or bad, an EV-type packet is not transmitted during the two bad hops but waits for the next pair of slots which happens to be a good channel. The bad channel degrades the HV3 link voice quality but an EV3 link can maintain a good voice quality. However, most Bluetooth slots are classified as bad when the 2.4GHz ISM band is occupied by more than two WLAN channels. By combining the test signal in BSIM with a new EV- type packet format, EBSIM can improve WLAN and still maintain the quality of the Bluetooth SCO link even when the 2.4GHz ISM band is completely occupied by the WLAN channels. But the disadvantage of this technique is the degraded quality of voice link.

E. META

META stands for MEDIUM ACCESS CONTROL (MAC) ENHANCED TEMPORAL ALGORITHM (META). META is one of the collaborative mechanisms. In the META technique, an 802.11 station and a Bluetooth node are collocated in the physical unit. META involves the use of centralised controller that monitors the Bluetooth and the 802.11 traffic, allowing the exchange of information between the two collocated radio systems. The controller works at the MAC layer, it provides per-packet authorisation of all the transmissions and uses its knowledge of the 802.11 and Bluetooth activity to predict collisions. When a collision might occur, META schedules transmissions based on simple rules determined by the packet types. In particular 802.11 acknowledgement packets have high priority than any

Bluetooth packets, while Bluetooth synchronous connection oriented (SCO) traffic has higher priority than any 802.11 data packets. But the use of centralized controller involves in this technique produce additional delay for the communication between the scheduler and the network node and also the hub of the network become quite complex and costly to implement.

F. ADAPTIVE FREQUENCY HOPPING

The technique of Adaptive Frequency Hopping has been introduced by the Bluetooth Special Interest Group (SIG) in collaboration with IEEE 802.15 working group to reduce the effect of interference from a wireless device. This technique allows Bluetooth channel to adapt to the environment by identifying the channels which are fixed sources of interference, so the signal can avoid that channel.

The Bluetooth device can detect the channel which Wi-Fi signal is using to communicate with its access points and will remove that channel from its hop sequence. This process also reduces the number of channels used by Bluetooth, thus increasing the risk of collisions among the Bluetooth channels.

G. *SCORT*

SCORT stands for Synchronous Connection Oriented with Repeated Transmission technique. It overcomes the disadvantage of the above mentioned techniques. In SCORT, SCO packet is transmitted three times repeatedly in one voice link. It replaces bit level redundancy with packet level redundancy. This technique ensures if the packet reception was failed due to the interference in first time slot there are still two other slots for successful reception.

III. INTRODUCTION TO SCORT

SCORT stands for SYNCHRONOUS CONNECTION ORIENTED WITH REPEATED TRANSMISSION. SCORT voice packet is used to avoid interference. In SCORT, the same SCO packet is transmitted three times repeatedly in a row. Thus there can be only one possible voice link instead of three in one time interval of 3.75ms. This technique ensures that if the first packet is received correctly then the other two packets are rejected. But if the packet reception is failed due to interference in first time slot, there are still two other slots for successful reception. There is no method of FEC in SCORT

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packet but still it is a very efficient way in robust communication to avoid interference, as it replaces bit-level redundancy with packet level redundancy. Thus use of SCORT voice packet is a good solution to avoid hindrance in case of voice signals.

A. ADVANTAGES OF SCORT

Advantages of SCORT technique are:

- SCORT achieves more robust transmission by replacing bit level redundancy by packet level redundancy.
- As in the SCORT technique, the same packet is being transmitted three times in a row, only one voice link will be there, which is a full duplex link.
- If interference destroys the transmission during first slot, there are still two other slots to communicate the packet. Thus, there is a much improvement in the frame error rate (FER) in an interference scenario.

B. DISADVANTAGES OF SCORT

The disadvantages of SCORT technique are:

- It involves only one voice link.
- No forward error correction is possible in SCORT.

IV. CONCLUSION

With the advancements in the wireless world, human being feels more relaxed and comfortable. They cannot imagine their daily life without the wireless communication. Bluetooth and Wi-Fi are the most popularly used wireless communication standards. They both are unbreakable part of technical world and operate in the same 2.5 GHz ISM band. But the situation gets worse as more and more devices come into play. Such a situation calls for the interference free network. For this there are various techniques. This paper presents the comparative analysis of all the techniques for the reduction of the interferences between Bluetooth and Wi-Fi. Out of all the techniques, SCORT technique is a big leap in the future. We hope by using the SCORT packets, we can minimize the effect of interference. It degrades the BER in the signal output. Thus the smooth voice transmission can be achieved by SCORT and finally a solution of coexistence without compromise can be realised.

ACKNOWLEDGMENT

We are highly thankful to Prof. Parveen Singh, Dean Academics, Mahant Bachittar Singh College of Engineering and Technology (MBSCET), Jammu for his useful guidance as and when required.

We also want to thank Department of Electronics and Communication Engineering, MBSCET, Jammu for their cooperation.

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