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Interference issues of WLAN 802.11b with Other Devices in ISM 2.4 Ghz Band.

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Abstract: *The paper presented deals with the issues of interference in ISM 2.4 Ghz band when WLAN 802.11b operating with other devices specially cordless phone and BT operated WPAN. From observation it is clear that WLAN 802.11b receive severe interference from both these devices because their power level coincide with each other, we have also observe that interference caused by BT will be more severe when it is in close proximity of WLAN. The interference issue becomes more serious when WLAN and WPAN are implemented on a single chip designed to share some radio components. The end result of interference can be degraded data throughput, reduced voice quality, or even link disconnection. The interference between WLAN and WPAN networks can be divided into two classes. The interference is said to be external if the interfering devices are physically separated by a distance of more than two meters. The interference is said to be internal if the devices are collocated, which is defined as a distance of less than two meters. In this paper we study the interference of WLAN 802.11b with other devices in 2.4 Ghz. In subsequent papers we suggest an effective mechanism to mitigate these interference in collocated devices.*

I. INTRODUCTION

IEEE 802.11b Wireless local area networking (WLAN)[1] also known as Wi-Fi, and Bluetooth (BT) Wireless personal area networking (WPAN)[2] have independently become the leading wireless networking technologies As the footprint and power consumption of both WLAN and Bluetooth devices is reducing, and with the introduction of new enabling applications, both technologies are finding their way into a growing number of devices. Both Wi-Fi and Bluetooth technologies utilize the unlicensed 2.4 GHz ISM band, technologies utilize the unlicensed 2.4 GHz ISM band, therefore leads towards interfering others performance. Other devices like cordless phone and Microwave owen also cause the interference to WLAN 802.11b in 2.4Ghz band, fig. (5) but they will not create severe effect on the performance in collocated device, because these signal are in the range of -63dbm to -30dbm. Bluetooth and Wi-Fi share the same unlicensed 2.4 GHz ISM band that extends from 2.4 to 2.4835 GHz under US FCC regulations. Therefore BT signal will strongly interfere WLAN performance Because these signals are in the range of -90dbm to -35 dbm Fig (6). However, systems in this band must operate under certain constraints that are supposed to enable multiple systems to coexist in time and place. FCC Part 15.247 specifies that a system can use one of two methods to transmit in this band: FHSS or DHSS [2] [1]. FHSS is a technique in which a device transmits an energy burst in a narrow frequency band for a limited time before it hops to another. This hopping process is repeated rapidly across the entire frequency band in a pseudorandom fashion. DSSS is a technique in which a device communicates by distributing its energy across a defined set of contiguous frequency bands without hopping.[1]

Bluetooth is an FHSS technology with frequency channels 1 MHz in width and a hop rate of 1600 hops per second. Bluetooth dwells 625 µsec in every frequency channel. In the United States and most of the world, Bluetooth uses 79 different 1 MHz frequency channels of the available 83.5 MHz in the 2.4 GHz ISM band.

Wi-Fi uses DSSS with a 22 MHz passband, and communicates with throughput up to 11 Mbps. A Wi-Fi system can use any of eleven 22-MHz wide sub-channels across the available 83.5 MHz of the 2.4 GHz frequency band.[1] Because Bluetooth hops on 79 of the available 83.5 1-MHz channels, and Wi-Fi occupies 22 1-MHz channels within its passband, sharing between the two technologies is inevitable. Two wireless systems using the same frequency band will have a high propensity to interfere with each other. 802.11b Ratified in 1999, the 802.11b standard adds 5.5 Mbps and 11 Mbps data rates to the original 1 Mbps and 2 Mbps 802.11 modes. 802.11b is the most popular wireless LAN technology. The higher data rates are achieved by using complementary code keying (CCK) DSSS technology. The CCK technology codes more data bits per 11 **spread** bits, 4 bits and 8 bits for 5.5 Mbps and 11 Mbps respectively, than 1 or 2 bits in the plain 802.11 standard while keeping the same bandwidth of the transmitted signal. It does this by first using 8 bit spreading sequence instead of the original 11-bit sequence. However, this 8-bit sequence still runs at a rate of 11 Mbps, which result in the same spreading factor of 11. Thus, the clock rate for data is increased from 1 Mbps to 1.375 Mbps (8*1.375=11). The CCK encoding does not use a static spreading sequence; six of the 8 bits are used to choose 1 of 64 complementary spreading codes. Different spreading codes are chosen based on the incoming data. Complementary Code Keying is furthermore explained in article [10].

II. System Background

IEEE 802.11 WLANs cover a range of approximately 100 m and can operate at bit rates as high as 11 Mb/s.We focus on systems that use the DSSS scheme and consider their bandwidth to be roughly equal to 22 MHz . The fundamental building block of the network is the so-called basic service set (BSS), which is composed of several wireless stations using the same spreading sequence and MAC function. The two fundamental MAC schemes defined in the IEEE 802.11 standard are the distributed coordination function (DCF) and the point coordination function(PCF) [1]. The former is based on the carrier-sense multiple access with collision avoidance protocol and allows for an asynchronous data transport; the latter is based on polling controlled by the access point and is able to support real-time traffic. In this paper, only the DCF scheme is considered. The basic architectural unit in BT systems is the piconet. Bluetooth uses frequency hopping as its access mechanism. The Bluetooth transmitter hops between 79 1-MHz wide channels with 1600 hops per second. On the other hand, 802.11b uses the listen-before-talk mechanism. It employs three specific, non-overlapping, 22-MHz wide channels. As a result, there is a 27.8% chance that Bluetooth will attempt to transmit inside a WLAN channel. Depending on the relative strength of the WLAN signal, either the Bluetooth signal or both the Bluetooth and WLAN signals will be corrupted and the receiver will not be able to decode the data. A 802.11 transmission is considered to be successful if no collision occurs on the RTS frame and both the data packet and the corresponding acknowledgment sent by the receiver are correctly received. Fig. 2 shows the 802.11 traffic timing in the case of successful packet transmission. If a packet is not correctly received, retransmission will take place according to the backoff procedure defined by the IEEE 802.11 standard. The number of retransmissions before the packet is discarded from the station buffer is limited and set to the Long Retry Limit. Fig 3 shows how successfully CSMA/CA transmission takes place.

III. FIGURES AND TABLES

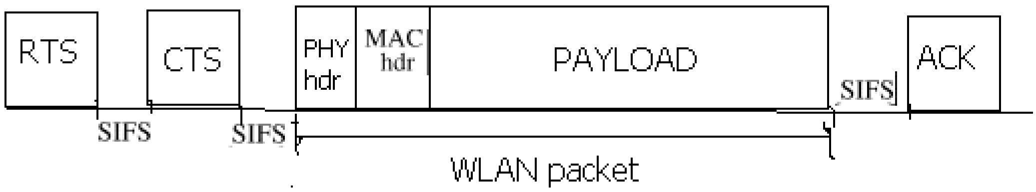

Fig. 1: Measured power spectrum of the combined LR-WPAN signal and the CW interference signal

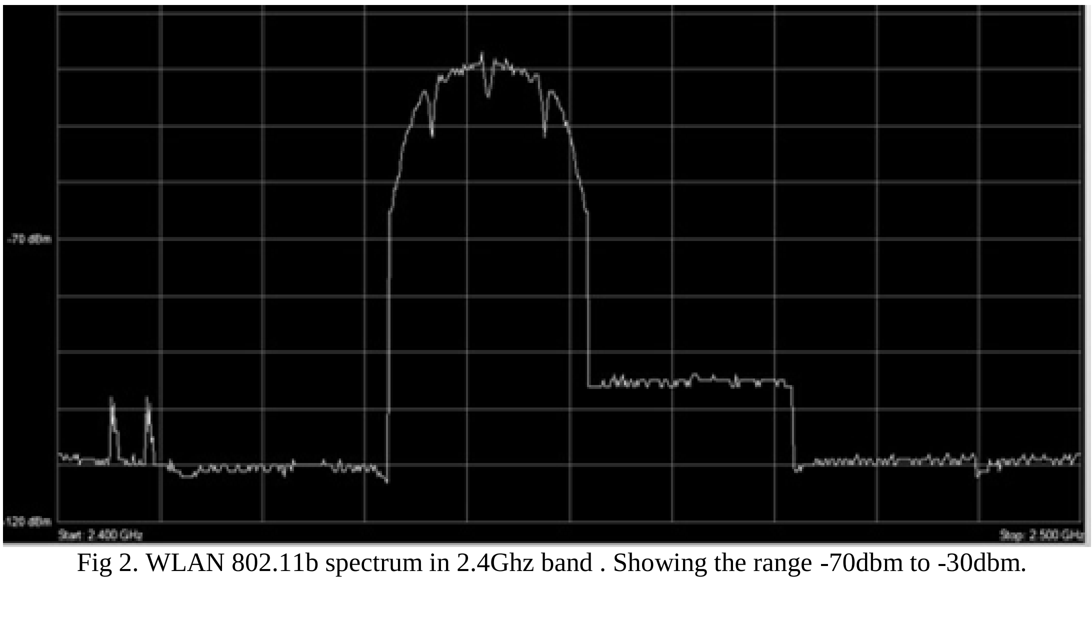

Fig 2. WLAN 802.11b spectrum in 2.4Ghz band . Showing the range -70dbm to -30dbm.

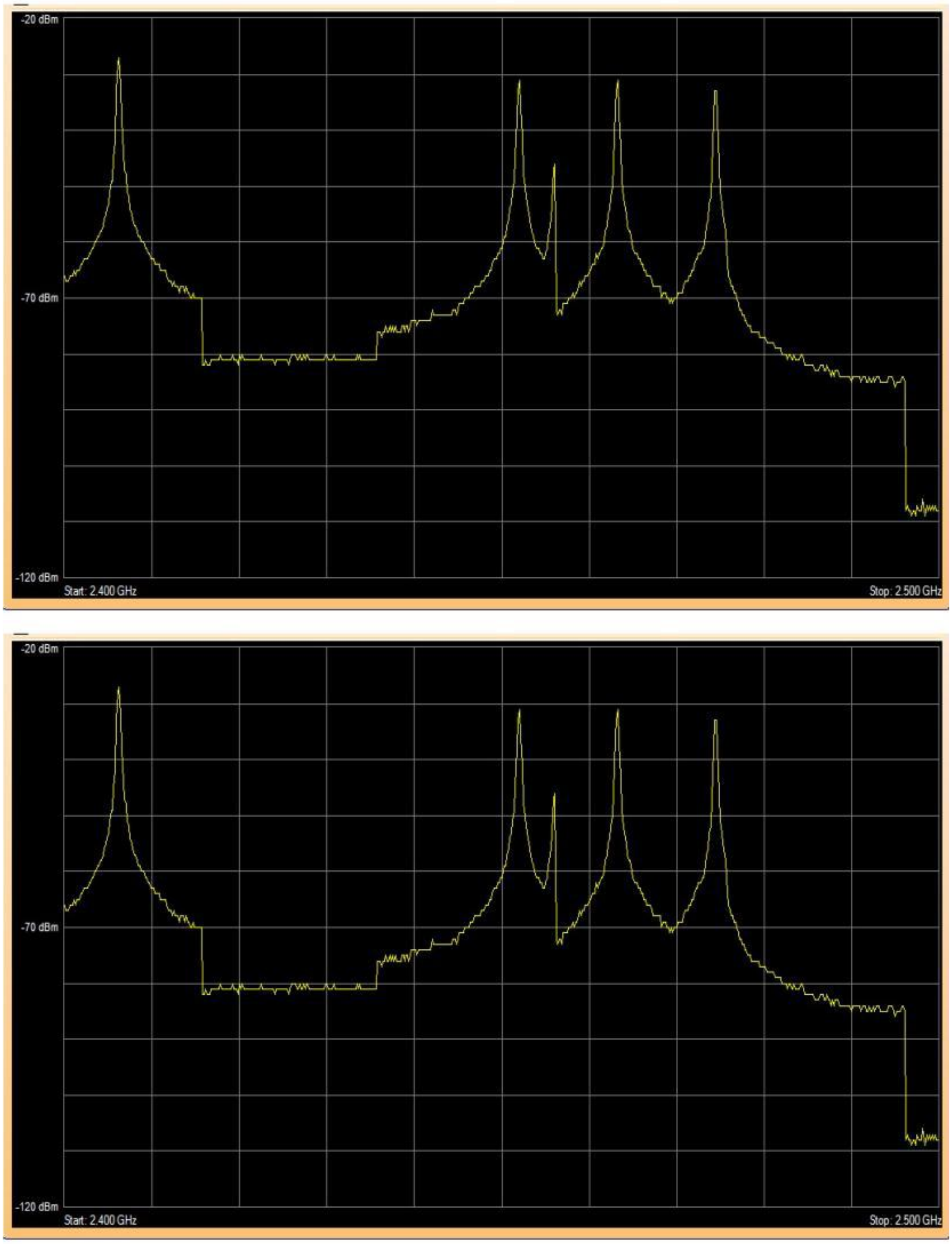

Fig 3 . Cordless phone interfering WLAN 802.11b signal in 2.4 Ghz ISM band, With power -63dbm to 30dbmISM band, With power -63dbm to -30dbm

IV. Interference Analysis of WLAN

Performance of WLAN 802.11b in 2.4Ghz is degraded when other devices are working in the same environment at the same time. wireless personal area networks (WPANs). Fig 3 shows the spectrum for 802.11b with -70 dbm to -30dbm.In particular, we consider IEEE 802.11b WLAN [3], and short-range radio systems based cordless devices and BT as shown in Fig. 5. And 6. It is quite clear from Fig 2,3 and 4 that there has to be sever interference if these devices operate simultaneously. These systems will operate in the 2.4-GHz industrial, scientific, and medical (ISM) frequency band, i.e., the unlicensed spectrum. BT uses a frequency-hopping spread spectrum (FHSS) scheme while IEEE 802.11 can either use an FHSS or a direct-sequence spread spectrum (DSSS) technique. WLANs and WPANs are complementary rather than competing technologies, and many application models have been envisioned for situations for BT and 802.11b to operate simultaneously and in close proximity [5]. Under these conditions, interference between 802.11 and BT occurs whenever the interference energy is sufficient to cause a decrease of the signal-to-interference ratio at the receiver and the two system transmissions overlap both in frequency and in time. According to the IEEE 802.15 working group, interference between 802.11b and BT causes a severe degradation of the systems' throughput when the distance between interfering devices is less than 2 m. A slightly less significant degradation is observed when the distance ranges between 2 and 4 m [7]. There needed a techniques that allow 802.11 and BT to operate in a shared environment without significantly impacting the performance of each other [6]. independently. To increase the WLAN performance results in [11] indicate that if one attempts to increase the MAC throughput by reducing re-transmissions via PER reduction, the physical layer processing time should not be increased substantially. Coexistence between the networks would be impaired, if the probability of packet collision between the networks is sufficiently large. The goal of the empirical tests provided in [9] was to provide a systematic study of the interference power required to disrupt packet transmission within the LR-WPAN.

V. CONCLUSION

It is quite clear from the observation and other papers studied in this regard, that performance of WLAN is severely degraded by other devices operating in the 2.4 Ghz band and there is no generalized technique to provide effective solution. Therefore a mechanism is needed which can provide a effective solution for coexistence of WLAN with WPAN and cordless devices in ISM band.

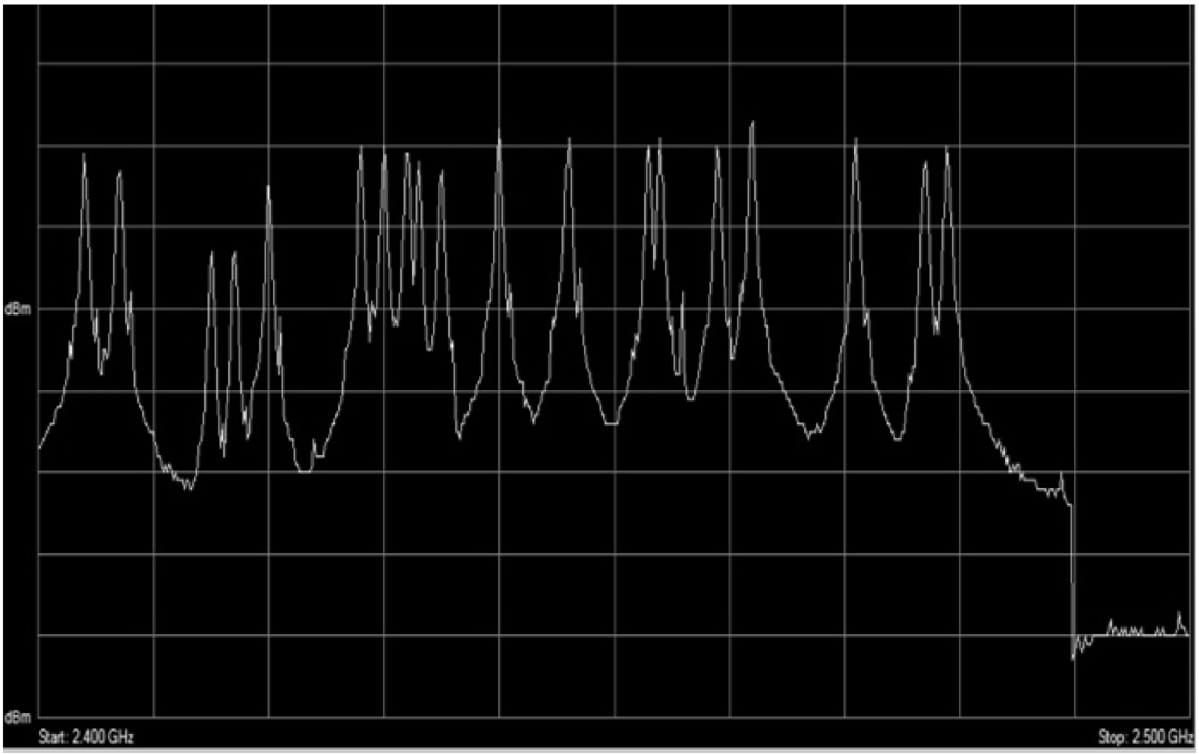

Fig 4. BT signal interfering WLAN 802.11b signal in 2.4

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GHZ ISM BAND. REFERENCES

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