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Scrutiny of Channel Quality of Wireless Universal Serial Bus in PAN Environment

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Abstract – Universal serial bus (USB) is one of the most successful industry standards for computers and digital devices. Wireless USB is a technological know-how that combines the comfort of wireless with the velocity and security that is characteristic of the USB. Therefore, it has been step by step evolving with the aid of a number of companies. In this paper, we implemented a wireless USB gadget primarily based on multi band orthogonal frequency division multiplexing (MB-OFDM) in wireless private region network (WPAN) and experiments had been carried out with a line of sight (LOS) and none line of sight (NLOS) environment. In addition, we measured the acquired sign energy indicator (RSSI), hyperlink nice indicator (LQI), packet error charge (PER), and statistics transmission price via experiments.

Keywords – Wireless USB, MB-OFDM, RSSI, LQI, PER.

I. INTRODUCTION

Recently, due to pastime in the enterprise 4 and the development of the web of issue (IoT) industry, there is a splendid need for digital gadgets in extraordinary fields to be wirelessly connected to each different to transmit or share data [1-3]. Especially, the demands for high ability multimedia data-oriented offerings and portability are rapidly increasing. Wireless prevalent serial bus(USB), one of the most famous technologies, combines wired USB technological know-how with ultra-fast wireless verbal exchange technology that is an ultra-wideband (UWB) [4-5]. UWB technique is a conversation science capable of highspeed data transmission over 500 MBPS with very little power consumption in contrast with present wi-fi transmission techniques such as wi-fi nearby area network (LAN) and industrial transportable terminal [6-7]. For wireless USB, multi-band- orthogonal frequency division multiplexing (MB-OFDM) technological know-how among various UWB applied sciences has been set as a standard, and a number software fields using the UWB technological know-how have started out to exhibit on the market [8-9]. However, the applications of wireless USB technology are nonetheless at an early stage, and an awful lot research is nonetheless wished to change short-range wi-fi conversation technologies, such as Bluetooth [10]. Therefore, in this paper, we investigate the performance of the wi-fi USB gadget in a number environments to exhibit the channel quality in wi-fi personal area network (WPAN) environment and analyze overall performance changes in accordance to with line of sight (LOS) and none line of sight (NLOS) environment. In addition, we measured the obtained signal strength indicator (RSSI), link high-quality indicator (LQI), packet error charge (PER), and records transmission charge thru

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experiments. The composition of this paper is as follows. In Section 2, short-distance wi-fi verbal exchange approach UWB and MB-OFDM are discussed. In Chapter 3, the wireless USB system used in the experiment is expressed in host and device cases. In Section 4, we describe the LOS and NLOS environments in which the test is performed and analyze the measured effects thru various parameters in every environment. Finally, Section 5 concludes.

II. SHORT-RANGE WIRELESS COMMUNICATION TECHNOLOGY

A. UWB

The UWB wireless transmission is a technique capable of imparting a transmission velocity from a hundred MBPS to 1 GBPS at a energy decrease than that of a traditional wi-fi transmission method such as a wi-fi LAN. UWB has been developed mostly as navy conversation and radar technology, but after being allowed to commercialize UWB with the aid of the federal communications commission (FCC), it has been actively developed as a brief distance wireless transmission approach for interworking between electronic devices. In the FCC, the UWB approach is defined as a wi-fi transmission technology having an occupied bandwidth of 20% or more of the middle frequency or occupying a bandwidth of 500 MHz or more. In general, UWB wireless transmission is a high-speed wi-fi verbal exchange method succesful of attaining a transmission pace of 100MBPS or extra at a transmission energy fulfilling the hassle standard (-41.3dBm) of high quality isotropically radiated electricity (EIRP) described through the FCC in the band of 3.1GHz to 10.6GHz. Since the band of the UWB radio transmission scheme overlaps with the band used via different radio transmission systems, it is allotted over a vast band with a small transmission power of -41.3 dBm or much less so that the frequency spectrum does now not interfere with different systems. Figure 1 indicates the transmission bandwidth and the power limit of the UWB. Figure 1 indicates that the bandwidth of UWB overlaps with the bandwidth of 802.11a.

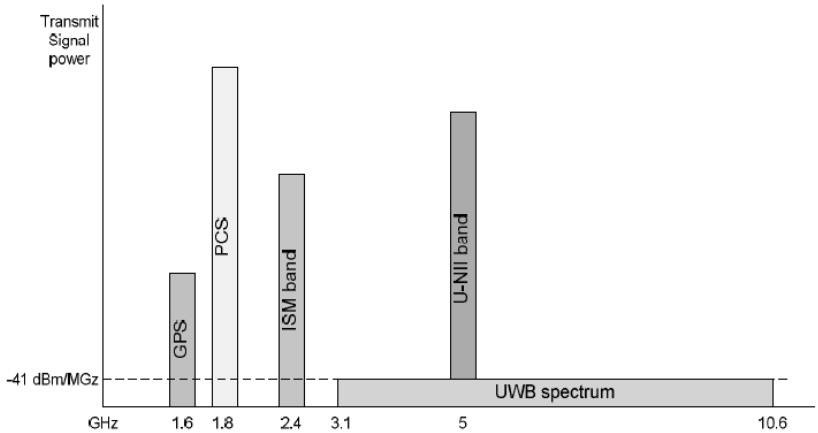

Fig. 1. UWB transmission bandwidth and power limit

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B. MB-OFDM

In MB-OFDM, 7.5GHz band from 3.1GHz to 10.6GHz, which is limited to interior wireless message field by the FCC, is divided into 14 sub bands with a bandwidth of 528MHz as shown in Fig. 2, and these sub bands are grouped into 5 groups respectively.

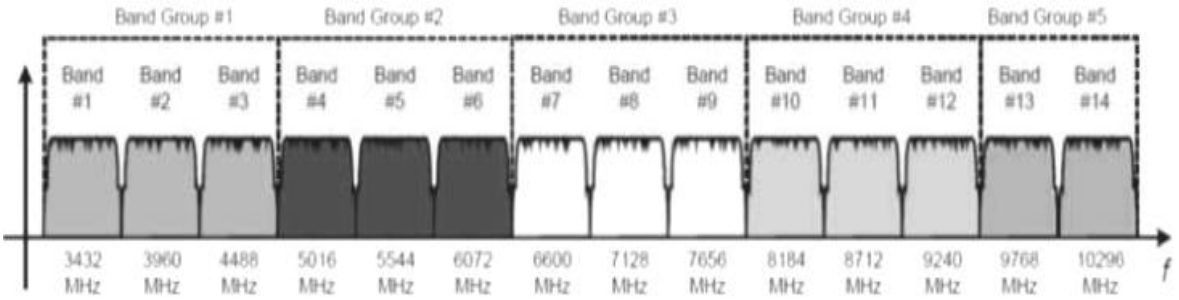

Fig. 2. Frequency distribution of MB-OFDM

According to the standard, band crew 1 (3.1 ~ 4.8GHz), which is the first team among the 5 band groups, is used mandatory, and this case is defined as mode 1. In the MB-OFDM, multiple subbands in the group 1 are allotted and frequency hopping is carried out in the frequency domain, thereby minimizing interference between simultaneously working piconets (SOPs) while imparting diversity gain. In this case, frequency hopping is performed according to the order of time frequency code (TFC), and there are ten kinds of frequency hopping patterns. Table I indicates the frequency hopping pattern.

Table I. Frequency hopping pattern

TFC Number	Base Sequence /Preamble	Hopping pattern					
1	1	1	2	3	1	2	3
2	2	1	3	2	1	3	2
3	3	1	1	2	2	3	3
4	4	1	1	3	3	2	2
5	5	1	1	1	1	1	1
6	6	2	2	2	2	2	2
7	7	3	3	3	3	3	3
8	8	1	2	1	2	1	2
9	9	1	3	1	3	1	3
10	10	2	3	2	3	2	3

III. WIRELESS USB

A. Host

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The wi-fi USB system used in the scan used to be a UWB chipset from Realtek, and MB-OFDM used to be used in UWB technology. The most facts price of the system is 480 MBPS at the physical layer and quadrature phase shift keying (QPSK) and dual carrier modulation (DCM) are used as the modulation method. The coding rate is 1/2, 1/3, 3/4 and 5/8, and the system parameters according to the transmission rate are summarized in Table II.

Table II. System Parameters

Data rate (MBPS)	Modulation	Code rate	Time spreading
53.3	QPSK	1/3	2
80	QPSK	1/2	2
106.7	QPSK	1/3	2
460	QPSK	1/2	2
200	QPSK	5/8	2
320	DCM	1/2	1
400	DCM	5/8	1
480	DCM	3/4	1

B. Device

The device system utilizes a realtek UWB chipset, which consists of a physical layer and a MAC layer. In the device, band group 1 and band group 3 are used among the five band groups of the MB-OFDM, and the in service frequencies are shown in Table III.

Table III. Operating frequency of band groups 1 and 3

Band Group	Band ID	Low Frequency (MHz)	Center Frequency (MHz)	Upper Frequency (MHz)
1	1	3168	3432	3696
	2	3696	3960	4224
	3	4224	4488	4752
3	7	6336	6600	6864
	8	6864	7128	7392
	9	7392	4656	4920

Table 4 also shows the receiver sensitivity and the error vector magnitude (EVM), which is the difference between the perfect waveform and the measured waveform, at the utmost data rate of 480 MBPS in band groups 1 and 3.

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Table IV. Receive sensitivity and transmit EVM

TFC Number	BG1, PHY Rate 480MBPS		BG3, PHY Rate 480MBPS	
	Rx Sensitivity (dB)	Tx EVM (dB)	Rx Sensitivity (dB)	Tx EVM (dB)
1	-74	-22	-72	-21
2	-74	-22	-72	-21
3	-74	-22	-72	-21
4	-74	-22	-72	-21
5	-75	-22	-73	-22
6	-75	-22	-73	-22
7	-75	-22	-73	-22
8	-74	-22	-72	-22
9	-74	-22	-72	-22
10	-74	-22	-72	-22

IV. IMPLEMENTATION AND RESULTS

A. LOS Environment

The investigational environment is shown in Fig. 3 in a together with this space of 8m and 8m in width and height, respectively.

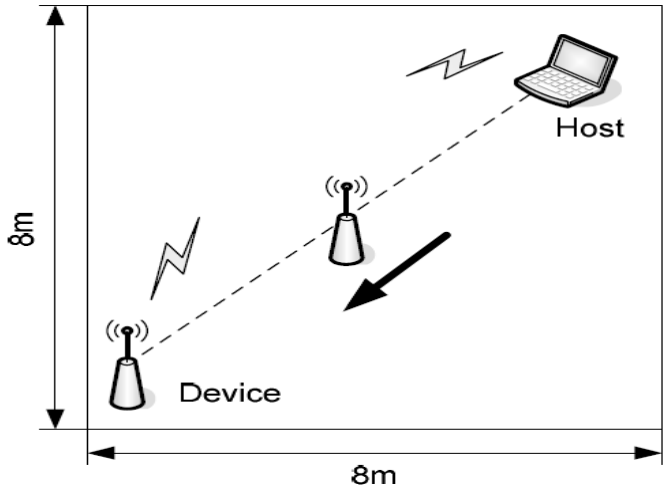

Fig. 3. 8m x 8m experimental environment

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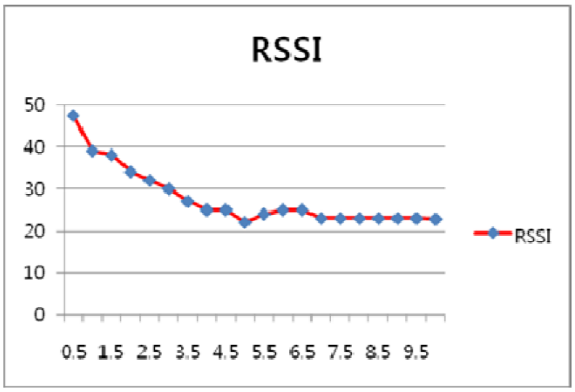

Fig. 4. Average RSSI in 8m x 8m environment

Figure 5 shows the LQI values measured in the environment of Fig. 3.

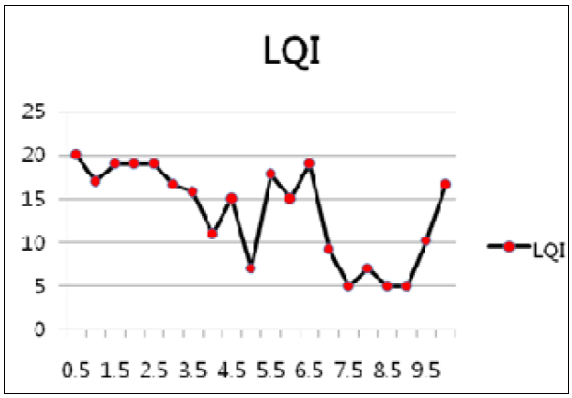

Fig.Fig. 5. Average LQI in 8m x 8m environment

Figure 5 additionally measures five instances at 0.5 m intervals at each point, and the parent is the common of 5 measurements. The horizontal axis in Fig distance and the vertical axis represents the LQI value. LQI is expected to minimize substantially as the distance increases. However, the LQI value decreases notably to 5m in proper measurement, and will increase again, and converges at about 10dBm.The difference between RSSI and LQI is that as the distance between the host and the gadget increases, the RSSI decreases slowly however the LQI changes significantly. As a result, LQI is greater affected by using multipath than RSSI.Figure 6 suggests the PER surroundings of Fig. three The PER the common value of 5 measurements, the horizontal axis represents the distance and the vertical axis represents the PER cost and the unit is percentage and the LQI, the PER indicates very good performance. The PER used to be 0% until 9.5m, and an error happened from 10m, which is 0.025%.

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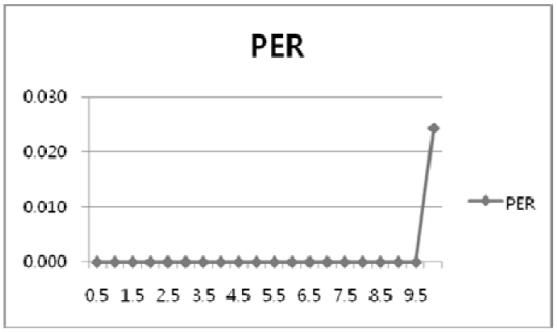

Fig. 6. Average PER in 8m

Figure 7 demonstrates the vary in transmission rate with distance. The results of Figure 7 gained by measuring five times at intervals of 0.5m at each point. The horizontal axis symbolizes the distance and the vertical axis represents the data rate was upholded over 170 gradually converged to 100 MBPS

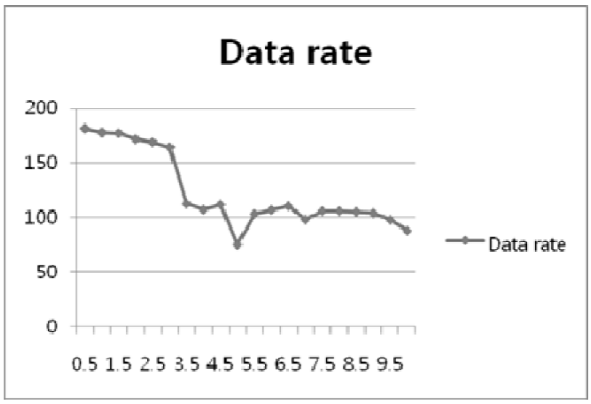

Fig. 7. Average data rate in 8m

B. NLOS Environment

Experiments in the NLOS environment were conducted in an enclosed house of 4m and 9 respectively with an X-marked obstacle, as shown in Fig. The host used to be fixed and the system used to be mounted at three special areas of A, B, and C to measure link quality. We measured RSSI, LQI, and records environment. At every site, the experiment was conducted 5 times in whole and the average was used as the measurement data. , 1, ISSN (Online): 2249–071X values measured in the fee at each point is also percent. Compared to the RSSI x8m environment are also the mean values transmission rate. The MBPS up to 3m, however it BPS after 3.5m distance.

V. CONCLUSIONS

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In this paper, we have applied wireless USB in WPAN environment, which has these days been recognized as a brief range and high speed verbal exchange technology. Experiments have been performed in LOS and NLOS environments. RSSI, LQI, and records fee were used as performance analysis parameters. Analysis of the information shows that even though the performance degrades with distance in the LOS environment, link first-class is high up to 10m. However, we can conclude that the performance of wireless USB structures is more affected via barriers than distance, considering that link nice is badly deteriorated in NLOS.

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