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Challenges of IEEE 802.11a technology and improving its performance using diversity technique

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ABSTRACT

In this technology, information can be transmitted through the air without the need for cables, wires, or other electronic connectors, using electromagnetic waves such as infrared, radio and satellite frequencies. In this research, the most important challenges and problems faced by wireless communication systems were identified and how to solve and address them. (IEEE 802.11aWLAN) was also simulated and tested using Mat lab program, where the signal generated in (IEEE 802.11aWLAN) was examined in the form of orthogonal frequency division multiplexing (OFDM) modulation by examining the performance of the bit error rate of this system using diversity technology to improve the performance of this system where we adopted the reception diversity technology, In the case of line of sight (LOS) channel and multipath channel using maximal ratio combining (MRC) method. We notice that the use of the MRC receiving diversity technique in the system reduces the bit error rate and increases the efficiency of the system and the performance improve with increase the number of receiving antenna with gain 6 dB.

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1. INTRODUCTION

In recent years, wireless communication has progressed significantly ,and this technology is considered one of the very important means of transmitting data between the sender and the receiver. The data is transmitted through the air without the need for any conductor, wire or cable, and this done by electromagnetic waves such as radio frequency and infrared radiation. Wireless communication technology refers to many wireless devices and other technologies such as smart phones, computers, and printers. Wireless communication can be defined as the transfer of data between two or more sites that are not linked to each other by any electrical connector.

Wireless local area network (LAN) is known as the brand name of Wi-Fi. These LANs are used in a government agency, hospital, company, or other organization. Figure 1 shows a wireless access point (AP) connected to a LAN via an Ethernet switch. The AP contains a transmitter and receiver that cover a specific geographical area in a building. This area extends to no more than approximately 100 meters, but the range is less due to large walls that attenuate the signal, floors, and other obstacles. Computers or mobile devices fall within this range, and they may have a radio modem that connects to the AP, which connects the computer or laptop to the main LAN. Figure 2 shows another common cone shape where an AP is connected to one or more of your internet service provider (ISP's) LANs via a long range connection such as T1 or T3 devices, fiber connection, or microwave relay link such as WiMAX. AP installs at airport, coffee shop, convention center. Anyone with a laptop with a LAN modem interface, connection to the AP and access to their email or

the Internet can. There are hundreds of thousands of hotspots around the world. There is another growing use of wireless LAN implementation of home networks see Figure 3. We note that the service of wireless local area network (WLANs) is like to that cordless phones. There is a big difference between WLAN and cordless phones in the required data rate. While cordless phones require (digital) speech transmission, which requires a maximum of 64 kbps, wireless LANs must be at least as fast as the internet connection [1]-[11].

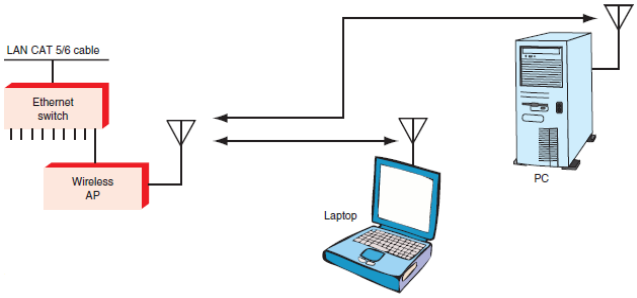

Figure 1. Access point extension to a wired LAN

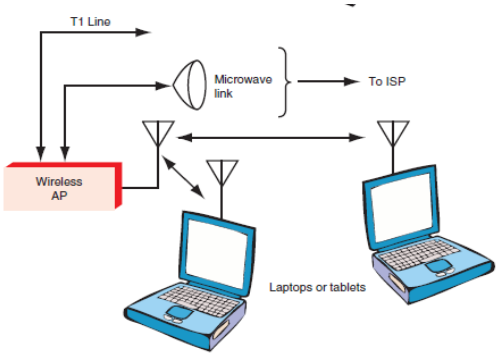

Figure 2. Public access point via an internet service provider

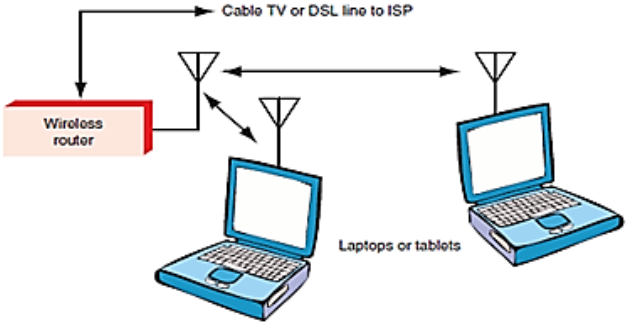

Figure 3. Home router for internet access

Fixed wireless access systems are a derivative of cordless phones or WLAN networks, which replace the designated cable connection between the fixed landline system and the user. Fixed wireless communication devices cover much wider distances (ranging from 100 meters to 10 of kilometers) compared to cordless phones. The distances covered by fixed wireless access devices are much greater (between 100 meters and tens of kilometers) than cordless phones. The goal of stationary wireless connectivity is to provide users with calls and data without extending cables from the main switching site to the site in which the users are located, and this is an economical approach. Personal area network (PAN) is a very small wireless network that is created, and this network contains two or more nodes in, some systems that connect a group of nodes in a small area. The well-known wireless PAN is Bluetooth, which is a standard introduced by ericsson mobile phones to use as an alternative to cables. Its goal is to provide hands-free cell phone operation by removing the cable that connects the cell phone to a headphone. Bluetooth is a standard, this standard is in a digital radio format and uses the frequency hopping spectrum (FHSS) with a bandwidth (ISM 2.4 GHz). It jumps over 79 spaced 1 MHz frequencies, except for 2.402 to 2.480 GHz. Jump rate is 1600 hops per second. Hence, the time spent in each frequency is 1y 1600 5625 μs. During this time, digital data is transmitted. The maximum bluetooth range is approximately 100 meters with a Class 1 capacity of 20 dB or 100 mW. Providing wireless connectivity in a small area with a coverage of 10 meters between a number of personal devices represents a goal for this technology, for example, portable computers, digital camera, and PDAs [2]–[12].

Metropolitan area networks (MAN) area networks are fiber networks, often synchronous optical network (SONET), that connect enterprise LANs to WAN or backbone networks. Other than that, MAN is

the local cable television network. WiMAX is designed to operate anywhere in the 2 to 6 GHz range in any area with the appropriate spectrum. Spectrum may or may not be licensed depending on its location and host country. The speed is determined by the frequency range, which ranges from 1.75 to 20 MHz. WISP will allocate bandwidth and speed to users based on their needs and fees [3]–[15].

There are a set of challenges facing wireless communication systems ,These systems use an open space to transmit signals, so there will be interference between the radio waves of the wireless system, and this thing happens in the Bluetooth and Wi-Fi technology, which operate at a frequency of 2.4 GHz, and if the two devices work together, the interference process will occur. And one of the important things in wireless communication is the security of information, and because of the transmission of signals in an open space, important information can be stolen and copied by an eavesdropper. Also, one of the health problems is constant exposure to radiation and it generates serious problems. And that the levels of radio frequency energy that cause danger and damage cannot be determined accurately, so it is advised not to be exposed to radio frequency radiation to the maximum extent. And the transmitted signal in the wireless medium suffers from limitations, reflection, diffraction, and scattering so the received signal will be visibly distorted and weakened. Portable equipment is designed to perform a number of instructions so that the power point installed on the stationary device cannot release much energy. To avoid this, the equipment must operate successfully and in an orderly manner to reduce the number of transmissions and receivers. So the data rate in these systems should be improved by reducing interference and data compression [16]–[20].

There are a number of problems facing WLAN and the important problem facing the local area network is that it is caused by the materials used in the walls and doors, which causes insufficient and smaller signal range. It is assumed that the solution to this problem is good planning in the design and construction of the hospital and the selection of suitable and suitable materials for walls, floors, and doors to provide the appropriate scope. Another problem is that external wireless LAN signals interfere with the waves generated by the hospital's private LAN, which leads to communication failure, if the signal from other access points is stronger. To maintain an active Wi-Fi environment, signals are supposed to reach the desired area with an intensity greater than the threshold. The presence of electronic products and medical devices of the same frequency may interfere with the wireless LAN. Also, some medical devices emit electromagnetic noise in the 2.4 GHz band. Allowing staff to carry personal communication devices causes security problems, as well as devices carried by patients and individuals, which can interfere with hospital radios. This can be avoided by transmitting sensor information from the hospital to the special device. Also, the lack of good planning as well as good information security leads to problems as anyone can access the hospital radios and monitor, change, destroy and manipulate information, good planning to maintain information security helps solve this problem and unauthorized communication can be prevented by using technology MAC address filtering at the access point [20]–[24].

2. ANTENNA DIVERSITY MODEL

A number of antennas are used in transmission or reception to solve the problem of signal weakness due to multiple paths. In case of transmitting diversity we use number of antennas in transmitting but in case of receiving diversity we use number of antennas in receiving [25]–[27]. In this paper, the receiving diversity was adopted in IEEE 802.11aWLAN. While NR is receiver anttenas, the channel expressed as (1).

$$\mathbf{h}=[h1h2\ \ldots..h_{NR}]^{T} \tag{1}$$

The received signal is:

$$y^{=}\sqrt{\frac{E_x}{N_0}}\boldsymbol{hx}\ +z \tag{2}$$

the average SNR for the (3):

$$\rho(MRC)=\frac{P_S}{P_Z}=\frac{E_x}{N_0}\ \frac{\left|W_{MRC}^{T}\right|^2}{\left\|W_{MRC}^{T}\right\|_2^2} \tag{3}$$

the upper bounded as (4).

$$\rho(MRC)=\frac{E_x}{N_0}\ \|\boldsymbol{h}\|_2^2 \tag{4}$$

3. MRC METHOD

It is necessary to collect uncorrelated fading signals to obtain the expected benefit of diversity, and the combined system must be designed in a way that improves performance, as the merging method works to strengthen the received signal and increase the percentage of (S/N) [27]–[28]. In this paper, the maximal ratio combining (MRC) method was adopted, this method is considered one of the best methods of merging. The Figure 4 illustrates this technique, as it requires a combination of weighing, assembly, and alignment circuits. In this technique, appropriate signal-level weights are chosen to increase the signal-to-noise ratio.

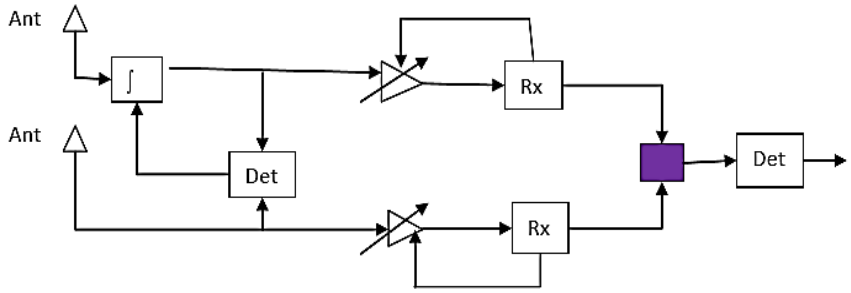

Figure 4. Maximal ratio combining

4. RESULTS AND DISCUSSION

In this paper the IEEE 802.11aWLAN communication system was simulated in the form of orthogonal frequency division multiplexing (OFDM) modulation, Figure 5 shows the bit error rate performance of this system without diversity technique, Figure 6 and Figure 7 show the bit error rate performance of this system with the MRC receiving diversity (1 Tx, 2 Rx) and (1 Tx, 4 Rx) respectively in line of sight (LOS) channel ,we notice from these figures that the use of the MRC receiving diversity technique in the system reduces the bit error rate and increases the efficiency of the system and the performance improve with increase the number of receiving antenna with gain 6 dB.

Figure 8 shows the bit error rate performance of this system with the MRC receiving diversity (1 Tx, 4 Rx) in multipath channel, figure We notice from this figure that the BER curve decreases due to the multipath fading in the multipath channel.

But Figure 9 and Figure 10 show the spectrum of received signal in multipath channel, Figure 9 shows a graph of the received signal for the wireless communication system in the frequency domain without filtering, while the Figure 10 shows a plot of the received signal in the frequency domain when using the finite impulse response (FIR) filter, From Figure 10 we notice that the frequency response to the received signal contains fewer side lobs, which increases the signal energy and improves the system's performance compared to the frequency response of the received signal shown in Figure 9.

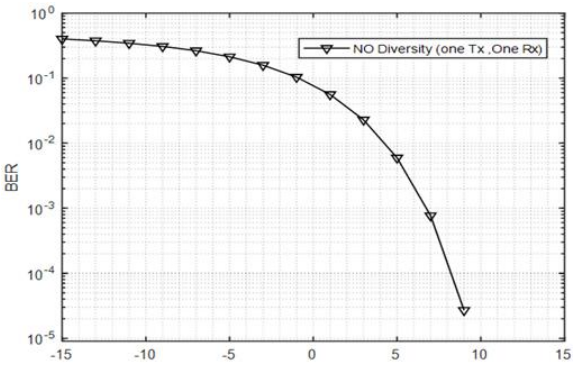

Figure 5. BER performance of IEEE 802.11aWLAN without diversity technique

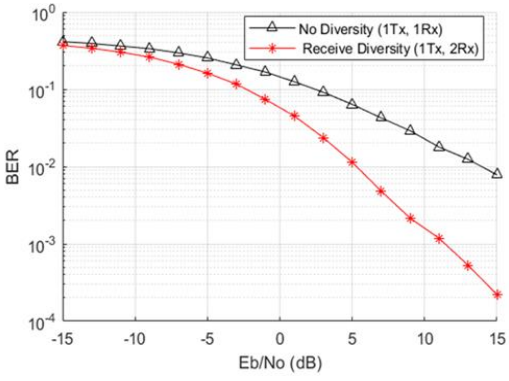

Figure 6. BER performance of IEEE 802.11aWLAN with MRC receving diversity (1 Tx, 2 Rx) in LOS channel

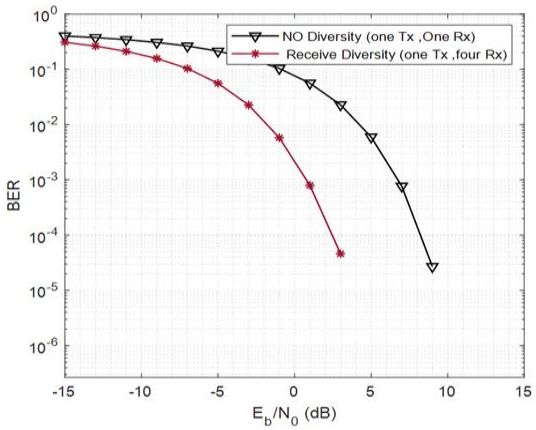

Figure 7. BER performance of IEEE 802.11aWLAN with MRC receving diversity (1 Tx, 4 Rx) in LOS channel

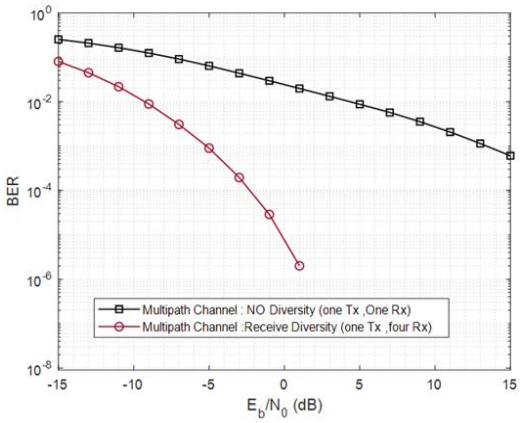

Figure 8. BER performance of IEEE 802.11aWLAN with MRC receving diversity (1 Tx, 4 Rx) in multipath channel

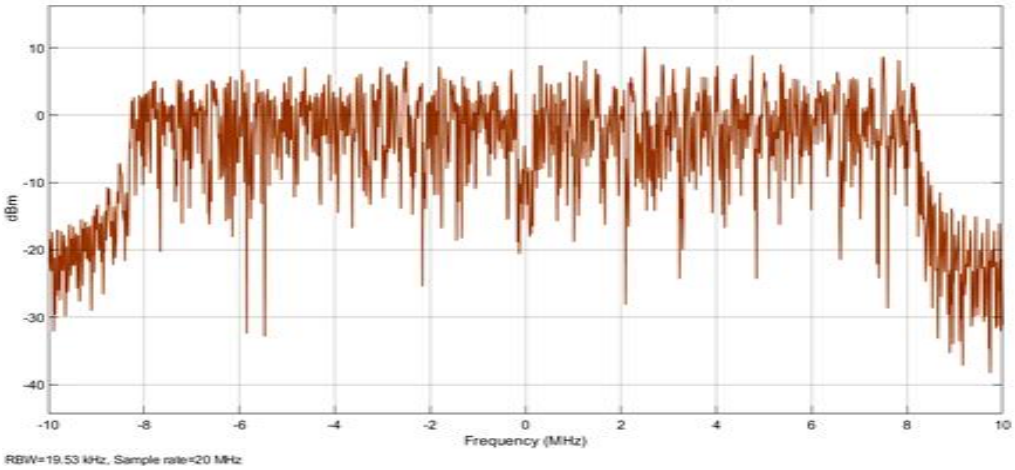

Figure 9. Frequency domain of signal in IEEE 802.11aWLAN without filter

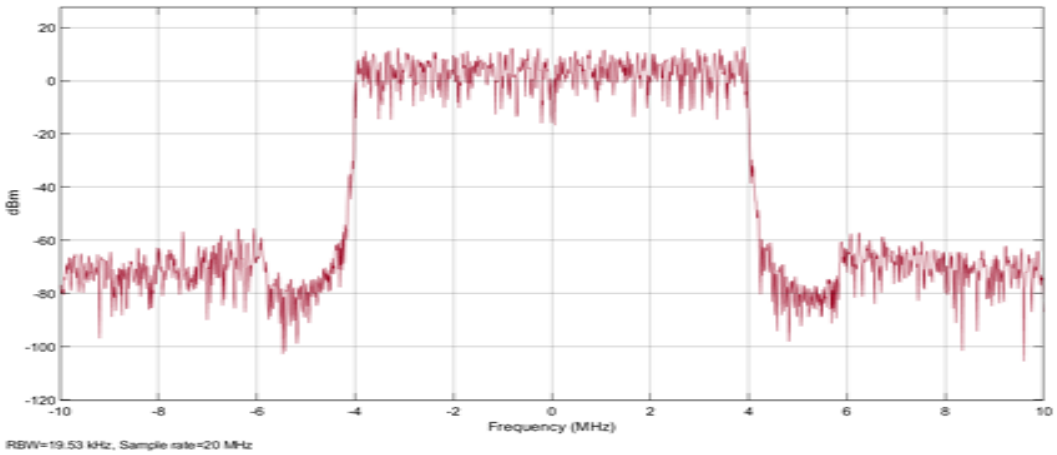

Figure 10. Frequency domain of signal in IEEE 802.11aWLAN with filter

5. CONCLUSION

Wireless communication technologies are characterized by their low cost, high reliability, and portability. In this research, the most important challenges facing wireless communication technologies were identified, such as interference between wireless signals, information security and health problems due to exposure to radiation, in addition to other challenges facing the signal in these technologies such as reflection, scattering and diffraction, which leads to weak signal. In this paper, the IEEE 802.11aWLAN communication system was simulated and tested using mat lab software, where we adopted the MRC method to improve the performance of this system in the case of LOS channel and multipath channel, where we found that the use of MRC receiving diversity technology in the system reduces the error rate bits and increases system efficiency and improves performance with increasing number of receiving antenna and gain 6 dB. The spectrum of the received signal in a multi-path channel without filtering was also examined, in addition to the examination of the spectrum of the received signal in the multi-path channel by adding FIR filter to get rid of the interference problem, strengthen the received signal and improve its performance and efficiency.

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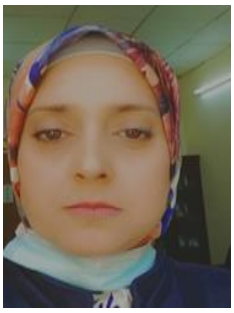

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