Exploit the benefits of MIMO to improve performance throughput for next generation wireless LANs

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Abstract: *Usage of multiple antennas (MAs) offers higher throughputs, improved reliability , and extended range of than conventional single antenna communications system . Herein, modification goals, in dense networks, at increasing per area throughput efficiency prevailed in both indoor and outdoor environments. In other hand, for each transmission mod that the actual throughput rate can then be computed for obtain length of the packet. Therefore, in this paper under all benefits that is owned these techniques will be exploit as simulation 802.11ac Packet Error Rate for MIMO with QAM modulation to show the improvement better throughput for next generation WLANs.*

1. Introduction

For given offering to designated the future generations of wireless communication system that is required some techniques such as spectrum , complexity limit and high data-rates. So that, fundamental changes in signal processing and system configuration might be required to enable effective and new ways of signal reception and transmission[1].

Now days , there is popularity growing network connectivity as user base wanting such as connecting of an Ethernet in airports, hotels, parks and conference centers, etc. therefore, wireless lane area network (WLANs) has been tracked with advanced growing in designed 802.11which be satisfying covering data transmission in anywhere[2]. Further, the WLANs is known as design to provide the data transmission network access between computing devices by using a cable infrastructure less than radio waves. In a small area such as office complex or building so the WLANs are designed to operate. Later two decades , in wireless LAN technologies, have witnessed starling advances where is by its increasing popularity in commercial complexes offering wireless access to their customers, and in the home due to ease of installation[3].

From [4] wherein Networking article and An IEEE Standards in Communications very good overview of past and current 802.11 projects is provided with "The IEEE 802.11 Universe" [5]. More than, the WLAN 802.11n was used From SISO to MIMO in the most applications[6] and also can note a reading of Measurement of WLAN 802.11 ac signals [7].

Moreover, as a viable solution for the next generation of and mobile, Multiple antenna(MA) technologies are being considered. The use of MAtechnologies offers higher throughputs, improved reliability and extended range than conventional single antenna communication systems . generally the MA can be separated into two main groups: spatial multiplexing based multiple-input multiple-output (MIMO) systems and smart antenna based systems [8].

Also therein the OFDM technique has their persist with the advanced standards communication due to its advantages. Based on OFDM so a 802.11g which provided 54 Mbps where higher data rates were demanded to support the many new and exciting devices and applications and for greater data density. And also there is based on OFDM in the 5 GHz band, 802.11a is providing 54 Mbps.Besides that, also a 802.11n operates in both the 5 GHz and 2.4 GHz bands [2].

Hence in the last decay the most devices in next generation approach 5 GHz that especially for commercial WLANs that it need an additional 400MHz of unlicensed spectrum. So 40 MHz operating modes in 802.11n is paved the way for the broad acceptance. For this case, the most cost effective way to increase the data rate is caused increasing the channel bandwidth when spectrum is free[2].

As well, such as increasing data rates of wired Ethernet that Market drivers were outlined wherein more data rate intensive applications, the need for higher capacity WLAN networks, and non-standard 100+ Mbps products entering the market. The presentation aforesaid techniques such as doubling the bandwidth and spatial multiplexingas potential approaches to study for increasing data rate.in mean will, tow documents necessary was completed for the creation of the High Throughput Task Group (TGn)[2].

Therefore, after obtaining all those explaining, obviously it seem to be here in this paper can exploit all characteristics for every to use them to provide us to the purpose improvement performance from simulation An 802.11n and 802.11ac VHT transmission of WLANs including MIMO based on OFDM technique within its channel mod.

1.1 MIMO System

Asystem with a transmitter with multiple antennas transmitting is called Multiple- input, multiple-output(MIMO) that describes the propagation through environment to a receiver with multiple with multiple receive antennas[2].So, due to their owned special characteristic so the MA technologies, are being considered as a viable solution wireless local area networks (WLAN) and the next generation of mobile[8].

Such a mathematic model for basic communication system can express as[2]:

$$y = \sqrt{\rho}.h.x + z \qquad (1)$$

where h is the channel fading coefficient, ρ is the average signal-to-noise ratio (SNR), x is the transmitted data with unity mean expected power, z is independent, complex additive white Gaussian noise (AWGN) with unit variance and zero mean and y is the receivedsignal.

For MIMO system can write

$$\begin{bmatrix} y_1 \\ \vdots \\ y_n \end{bmatrix} = \sqrt{\rho}\begin{bmatrix} h_1 \\ \vdots \\ h_n \end{bmatrix} x + \begin{bmatrix} z_1 \\ \vdots \\ z_n \end{bmatrix} \qquad (2)$$

There are many of demands such as complexity limits, spectrum, and high data-rate under tight power that they are satisfied with MIMO architecture. Thus, this identical what the future generations of wireless communication systems are designated[1].

For each tap that The MIMO channel matrix H, at one instance of time can be separated into a fixed matrix and a Rayleigh matrix{(constant, LOS),(variable,

NLOS),respectively}[8][9].

$$H = \sqrt{Q}\left[\sqrt{\frac{L}{L+1}}H_F + \sqrt{\frac{L}{L+1}}H_v\right] \qquad (3)$$

$$= \sqrt{Q}\left[\sqrt{\frac{L}{L+1}}\begin{bmatrix} e^{j\emptyset_{11}} & e^{j\emptyset_{12}} & e^{j\emptyset_{13}} \\ e^{j\emptyset_{21}} & e^{j\emptyset_{22}} & e^{j\emptyset_{23}} \\ e^{j\emptyset_{31}} & e^{j\emptyset_{32}} & e^{j\emptyset_{33}} \end{bmatrix} + \sqrt{\frac{L}{L+1}}\begin{bmatrix} X_{11} & X_{12} & X_{13} \\ X_{21} & X_{22} & X_{23} \\ X_{31} & X_{32} & X_{33} \end{bmatrix}\right] \quad (4)$$

where P is the power of each tap L is the Ricean L-factor, Xij (i-th receiving and j-th transmitting antenna) are correlated complex Gaussian random variables, unitvariance, zero-mean as coefficients of the variable NLOS (Rayleigh) matrix HV, and exp($j\emptyset ij$) are the elements of the fixed LOS matrix *HF*. We obtain that the complex Gaussian assumption is valid when we assume each tap consists of a number of individual rays. *P* in (3) represents the sum the variable NLOS power (sum of powers of all taps) and the fixed LOS power.

1.2 the standards(IEEE 802.11n , IEEE 802.11ac) and WLANs

1.2.1 thestandards(IEEE 802.11n , IEEE 802.11ac)

Improving in spectral efficiency (SE) as well as the quality transmission is introduced in IEEE 802.11n with the MIMO technique. Thus, considering the data rate up to 600 Mbps is supported in 40MHz and 4_4 MIMO configuration.[10]. In the 802.11n context, there are three levels which investigated by the MIMO technique. First, based on multiple antennas array, using the receiver diversity at the receiver's side. secondly, encoding NSSspatial streams into *NSTS* space-time streams when it used space time block encoder(STBC). And, the third is using spatial mapper for beamforming or spatial expansion when into NTXtransmit chains spreaded via the NSTSspace-time streams[10].

Further, during the development of the 802.11n standard, path loss models and set of channel models were created. So, based mostly on indoor measurements, the propagation models were developed due to the nature of typical WLAN deployments. And, the correlation matrix considers a keycomponent of the channel models which affects MIMO system performance. Thus,for a range of indoor environments, the channel models are composed. Therein, developing a set of antenna correlation matrices and impulse response were incorporated, applicable to both bands, for measurement data from both the 2.4 GHz and 5 GHz frequency bands[2].

Moreover, an evolutionary improvement to 802.11n is 802.11ac. There are many goals for the 802.11ac. one of them is to convey higher levels, with Gigabit Ethernet networking, of performance that are commensurate[11]. In the same time, for higher throughput in the 5-GHz band consider a set of physical layer enhancements such as 802.11ac when to achieve this it extends the techniques pioneered, and chiefly with video in mind in802.11n. so that, here it will promise with wider channel, more antenna, reliability, boosting throughput due to along with a number of new features and more spatial streams[12].

Therefore, the 802.11ac task group (TGac) has chosen to expand the channel width from 40 MHz in 802.11n to 80 and 160 MHz due to from more spectrum enables higher throughput as a fundamental rule of wireless communication[11]. So this stander can convey wireless throughput of 500 megabits per second or more. Also, it narrowed the gap which it consist when the wired network was being still vastly its performance in one area[13].

1.2.2 Wire Lees Networks Area (WLANs)

The need to interconnect several devices(such as laptops, printers, desktop, cable modems, switches and so on) is created due to the popularization of computers at home. WLAN became attractive as it gave mobility to laptops and did not require wires, but it require the RF spectrum when it to be implemented. So, by government agencies that the RF spectrum is regulated. Therefore, using this spectrum by users need to obtain licenses. As well, the WLAN has its specifications when it use with stander protocol. For this, A global association WEA (Wi-Fi Alliance) assure inter-operability through a certification program and [14].

Tow possible implementation of the WLAN are for anticipated in the standard[14]:

- Infrastructure Basic Service Set (IBSS)in which this is an ad-hoc implementation that all elements have the same functionality and hierarchy so an element is called station(STA). STAs can perform Distribution Service(DS), and also establish communication directly between themselves, by relaying information to other STAs.

- Infrastructure Basic Service Set(InfraBSS):This implementation needs an infrastructure element that concentrates all performs and communications the STAs from DS and portals.This infrastructure element is called Access Point (AP) and accumulates the function of a DS and a STA.

On the way is more and better wireless. Many improvements and benefits are offered by it over current systems.Some of main trends in wireless include[15]:

- Advanced standards should be introduce new as being the forthcoming 5G wireless.
- Maintaining 5G transitioning in the cellular system while 3G/4G compatibility.
- For achieving the higher data rates due to increased use of broadband modulation schemes require using technique like OFDM.
- New millimeter bands from 24 to 40 GHz as well as new bands in the 3- to 6-GHz range should be offer, at the higher frequencies, the availability of more spectrum.
- The requirement of adding agile beamforming and MIMO that cause improved link reliability and higher data rates.
- The lager macro base stations replaced with multiple small cells for each coverage area.
- Especially in small cells that the pressing need for lower power consumption.

1.3 Packet Error Rate (PER) and Throughput(TH)

A metric choice to compute, experiencing block fading, the practical performance of communication system that is the (PER) packet error rate. The PERare applied to the study of the impact of system parameters,for TCP-based data applications and VoIP,of system parameters on the quality of service(QoS)over WLANs.we provide insights into how system parameters such as data rate can be selected to guaranteeensure efficient usage of user and system resource andthe "user-required QoS" whenstudying the trade-off betweenchannel time and the user's QoS, energy consumption[16].

In addition totransmission errors,the channel conditionsare also a function of system parameters such as code rate and modulation(data rate)the packet size andtransmit power. In WLANs as selection/adaption,there is signification amount of prior work on system parameter[16].

Moreover, the average packet size, number of users, bandwidth, and the type of implementation are depended of them the effective through of an 802.11n network. So, for different scenarios of number of users and average packet size. As well, The spectral efficiencyis achieved only for a 5 MHz channel and does not go above 2.4 bit/Hz. The goal of 802.11n , only achieved on paper, was to achieve 3 bit/Hz. But, it can achieve is 1.6 bit/Hz with 1 user only as the best in reallife. Thus, Throughputwas not accounted for as it varies significantly when it was increasing due to Space Time Coding (STC)[14].

In general, for each transmission mode, the actual throughput rate, can then be computed for a given length of the packet. Then, throughput rate can be used to select a suitable transmission mode as well as the estimates. Also, due to transmission errors in the channel that packet loss is a function of packet error rate[16]

2. Dissection the results of simulation

After of all studies those techniques that is described in section 1.3. we should using a MATLAB programing to simulate PER vs SNR for 8×8 channel model D-NLOS for WLANs with the using stander protocol 802.11ac to see the effect on throughput. This is operating under the condition of parameters as80 MHz channel bandwidth,8 transmit antennas,8 space-time streamsand type of modulation is256-QAM rate-5/6.

TABLE 4-1: represent SNR vs PER for different number of packets when distance in meters for NLOS = 15 m

SNR(dB)	Number of packets	PER
40	11	1
45	15	0.73333
50	130	0.046667

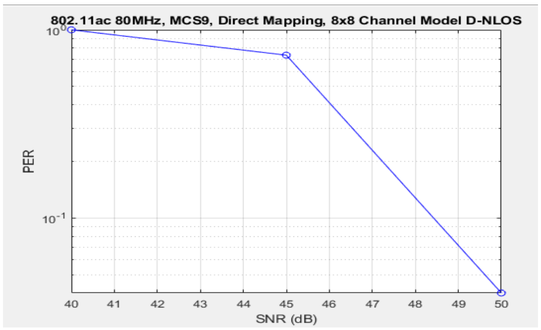

Fig. 4-1 represents the SNR vs PER for different number of Packets when distance in meters for NLOS = 15 m

TABLE 4-2: represent SNR vs PER for different number of packets when distance in meters for NLOS = 10 m

SNR(dB)	Number of packets	PER
40	15	0.84615
45	19	0.64706
50	150	0.046667

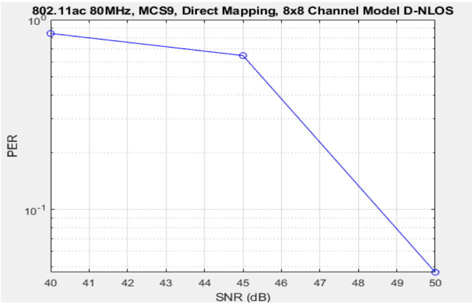

Fig. 4-2 represents the SNR vs PER for different number of Packets when distance in meters for NLOS = 10 m

TABLE 4-3: represent SNR vs PER for different number of packets when distance in meters for NLOS = 5 m

SNR(dB)	Number of packets	PER
40	15	0.73333
45	19	0.57895
50	150	0.046667

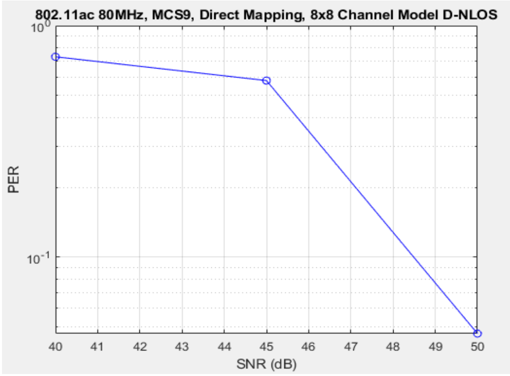

Fig. 4-3 represents the SNR vs PER for different number of

Packets when distance in meters for NLOS = 5 m

First, through the three tables above(without using OFDM)and their graphics(Fig.4-1to4-3)can say the PER will be better gradually that is yield to improvement in throughput against the same values of SNR.

TABLE 4-4: represent SNR vs PER for different number of packets

when distance in meters for NLOS=5m with OFDM technique

SNR(dB)	Number of packets	PER
40	15	0.84
45	19	0.53864
50	150	0.06

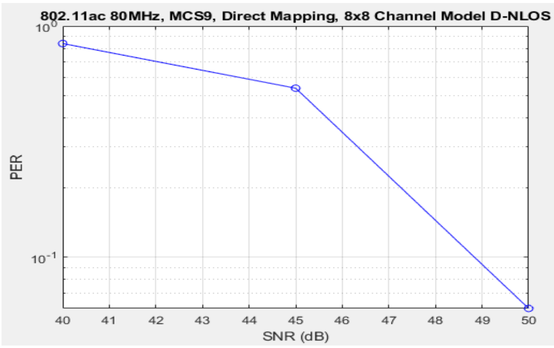

Fig. 4-4 represents the SNR vs PER for different number of

Packets when distance in meters for NLOS = 5 m and

Using OFDM technique

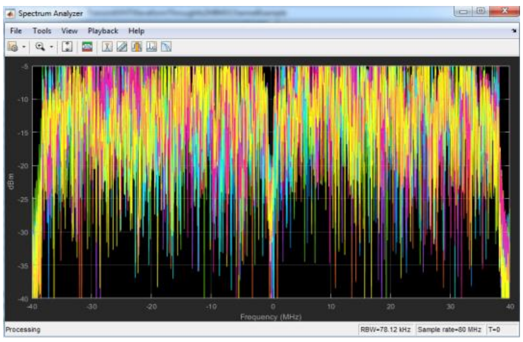

Fig. 4-5 represents the received signal without OFDM

Secondly, viewing to Fig.4-4 where is using OFDM technique here that will obtain the better performance to the throughput than first case above.

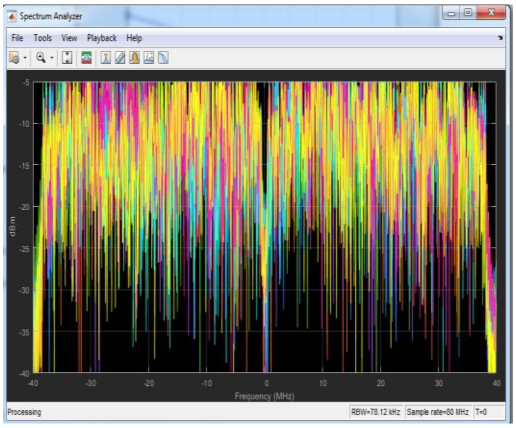

Fig. 4-6 represents the received signal with using OFDM

Whereas, foe seeing the last figures Fig4-5 and Fig.4-6 which represent the received signal for two cases without using OFDM and with using OFDM, respectively. Herein, they will appear the signal in the second case more density than the first case. This provide the advantages of using OFDM technique as better wideband efficiency and less selectivity frequency. Thus, will have a good symbol rate.

3. Conclusion

From results simulation that are discussed in previous section, the important fact is appeared. Whereas, the PER is improved more and more with different conditions. All of thoseimprovements will give to the throughput to be high.

So that, the impact of system parameters are applied , on the quality of service (QoS), to be study for TCP-based data application and VoIP over WLANs as knowing the packet loss is a function PER due to transmission in the channel.

Herein, using OFDM with QAM modulation beside MIMO technique that are reached to the best PER as shown before. Thus, it will provide the good promise to exploit for next WLANs generation.

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