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Performance Evaluation of Wi-Fi Network

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Abstract: ***Wi-Fi networks are played important role today in wireless communications and preferred from other wireless technologies because of its high bit rate and large bandwidth. The objectives of this paper are to study, analyze, plan and simulate the Wi-Fi network to evaluate the performance of Wi-Fi network using Matlab simulink software program. The parameters, used for the evaluation, are Additive White Gaussian Noise (AWGN) and Flat fading. The performance evaluation is explored in terms of Packet Error Rate (PER) ratio versus the Signal to Noise Ratio (SNR) in dB in graphical form.***

Keywords: Wi-Fi, WLAN, AP, PER, SNR, SIMULATION, OFDM

1. Introduction

Wireless Local Area Networks (WLANs) extend the reach of Local Area Networks (LANs) by providing wireless connectivity. Designed originally for cable replacement incorporate environments, WLANs have become very popular in providing IP connectivity in residential, small office and campus environments. WLANs have experienced phenomenal growth and are now a crucial part of the computer networks. Generally, Wi-Fi refers to any type of IEEE 802.11 Wireless Local Area Network (WLAN) [1].

Wi-Fi networks have become very popular in recent years. Many users have installed Wi-Fi networks at home, and numerous corporations have added Wi-Fi access points to their wired networks, giving employees easier access to corporate data and services [2].

There are many previous studies which reported Wi-Fi technology; we briefly describe a few of these studies. The first paper provides a comparison and technical analysis of alternatives for implementing last-mile wireless broadband services. It provides detailed technical differences between 802.11 (Wi-Fi) wireless networks with 802.16 (WiMAX), This work has proved that the WiMAX standard goal is not to replace Wi-Fi in its applications but rather to supplement it in order to form a wireless network web[3]. The second paper explores the potential of using Wi-Fi signals and recent advances in MIMO communications to build a device that can capture the motion of humans behind a wall and in closed rooms. Law enforcement personnel can use the device to avoid walking into an ambush, and minimize casualties in standoffs and hostage situations. The objective of this paper is to enable a see-through-wall technology that is low-bandwidth, low-power, compact, and accessible to non-military entities [4]. An M.Sc thesis [5] reviews the operation of 802.11 and its extended MAC layer, 802.11e. Then review some analytical models used to explore the behavior of the 802.11 MAC and test some of the assumptions underlying these models, they made a test-bed to investigate the effects of the 802.11e parameters, and made a measurement such as delay, throughput, collision probability and the driver queue occupancy.

This paper evaluates the Performance of Wi-Fi network under Additive White Gaussian Noise (AWGN) channel only without fading and then with flat fading with AWGN.

2. Description of Wi-Fi Network

Recently Wi-Fi network is more popular technology used worldwide in internet since it has the many specifications and advantages such as speed of connection by Wi-Fi about 54 Mbps, low cost and mobility during the connection.

Wi-Fi is a short name for Wireless Fidelity. There are many standards for Wi-Fi network, Differs in terms of its design, specifications, range and application: standard a- operating in the 5 GHz with data rate up to 54 Mbps, Standard b- operating in the 2.4 GHz with data rates up to 11 Mbps, e- for Quality of service and prioritization, f for Handover, g operating in 2.4 GHz with data rates up to 54 Mbps, h- Power control, i-for Authentication and encryption, j – Interworking, k- Measurement reporting, n - operating in the 2.4 and 5 GHz with data rates up to 600 Mbps, s - Mesh networking, ac - operating below 6GHz to provide data rates of at least 1Gbps per second for multi-station operation and 500 Mbps on a single link, ad - providing very high throughput at frequencies up to 60GHz and af - Wi-Fi in TV spectrum white spaces [6].

Today's Wi-Fi networks operate in one of two frequency ranges: 2.4 GHz and 5.8 GHz. 802.11b and 802.11g operate in the 2.4 GHz realm while 802.11a sticks to the less-used 5.8 GHz band. 802.11b and 802.11g wireless implementations far outnumber 802.11a networks although 802.11a and 802.11g both sport relatively fast speed, 802.11a has a maximum range of 25 meters while 802.11g can range from 25 up to 75 meters, depending on environmental susceptible to interference from cordless phones, microwave ovens and more [7].

The Wi-Fi network is based on a cellular architecture and consists of two main components: cell or Basic Service Set (BSS) and Base Station or Access Point (AP). The coverage area of AP can be up to 114 m, and it supports up to 200 users. When users want to connect to the Wi-Fi network, there are two modes: peer to peer mode or client/server mode [8].

Wi-Fi system use adaptive modulation and varying levels of forward error correction to optimize transmission rate and error performance. Wi-Fi use two primary radio transmission techniques: Direct Sequence Spread Spectrum (DSSS) and Orthogonal Frequency Division Multiplexing

(OFDM), also Frequency Hopping Spread Spectrum (FHSS), but that has largely been abandoned [9].

3. Simulator Parameters

The parameters which are taken into consideration of the simulator were depicted in table (1) below:

Table 1: parameters of simulation

Parameter	*Value*
Modulation	Adaptive Modulation
SNR	0-30 dB
Noise	AWGN
Fading	Flat fading
Doppler Shift	50-150 Hz

4. Simulation

The simulation block diagram was depicted in figure (1) bellow:

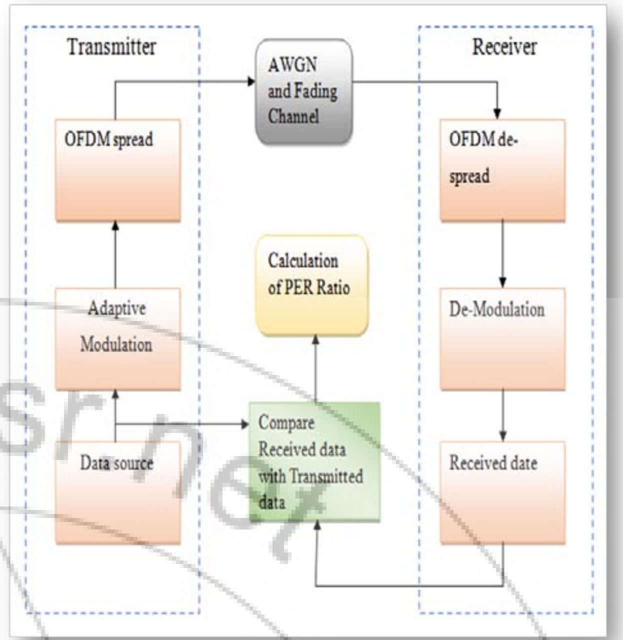

Figure 1: Wi-Fi simulink Model

The baseband signal of data source was generated with the variable rate, then the base band signal was modulated using adaptive modulation, after that the narrow band modulated signal was spread using Orthogonal Frequency Division Multiplexing (OFDM), that divide the data into multiple parallel sub streams at a reduced data rate, each sub stream is modulated and transmitted on a separate orthogonal subcarrier, that increases symbol duration and improves system robustness [10].

At the channel the signal were impaired by AWGN and flat fading. At the receiver, the reverse operations of the transmitter have been done; De-spread and De-modulated, then the received signal was compared with the transmitted signal and the Packet Error Rate (PER) was explored.

5. Results

The results of PER were obtained versus SNR after the execution of the simulation as shown in figures 2, 3, and 4 below

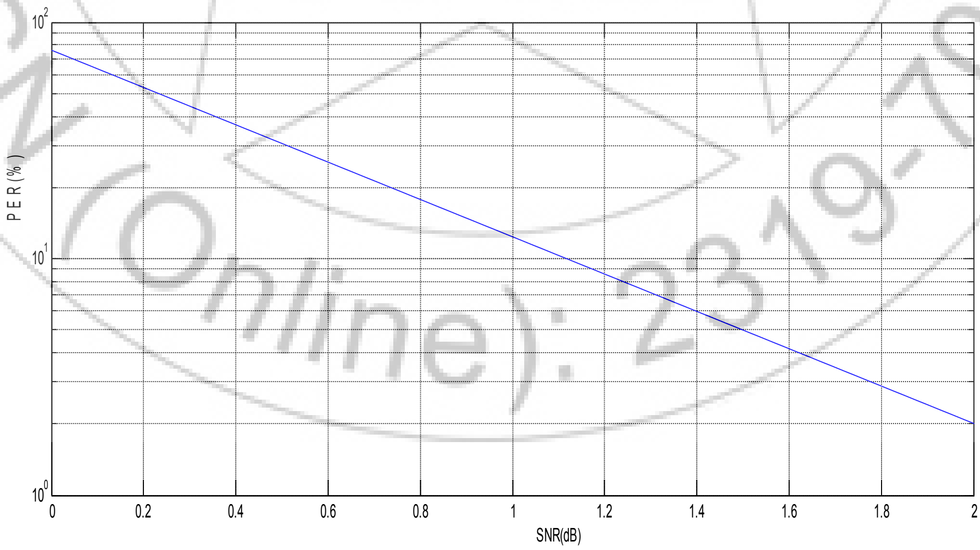

Figure 2: Relation between PER (%) and SNR (dB) when Doppler shift is 50Hz.

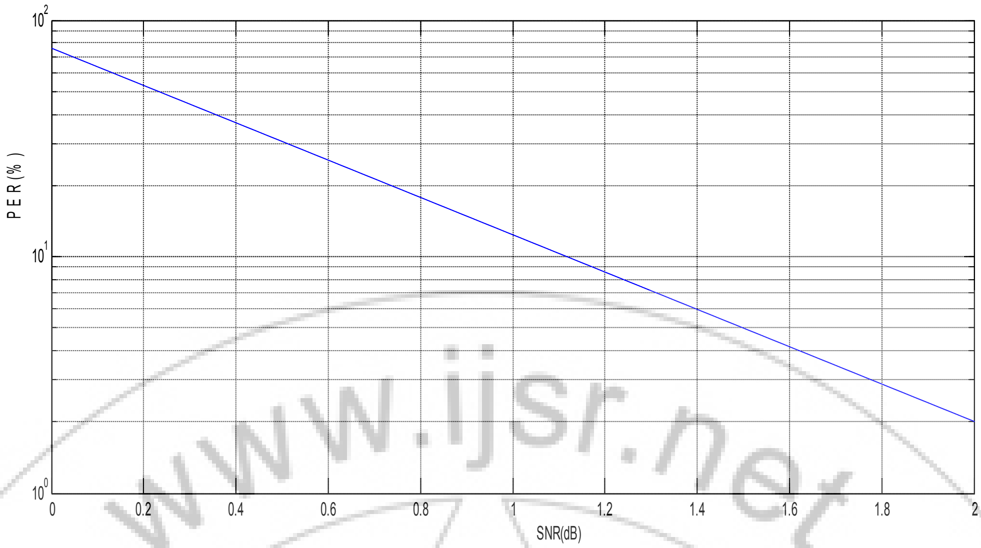

Figure 3: Relation between PER (%) and SNR (dB) when Doppler shift is 100 Hz.

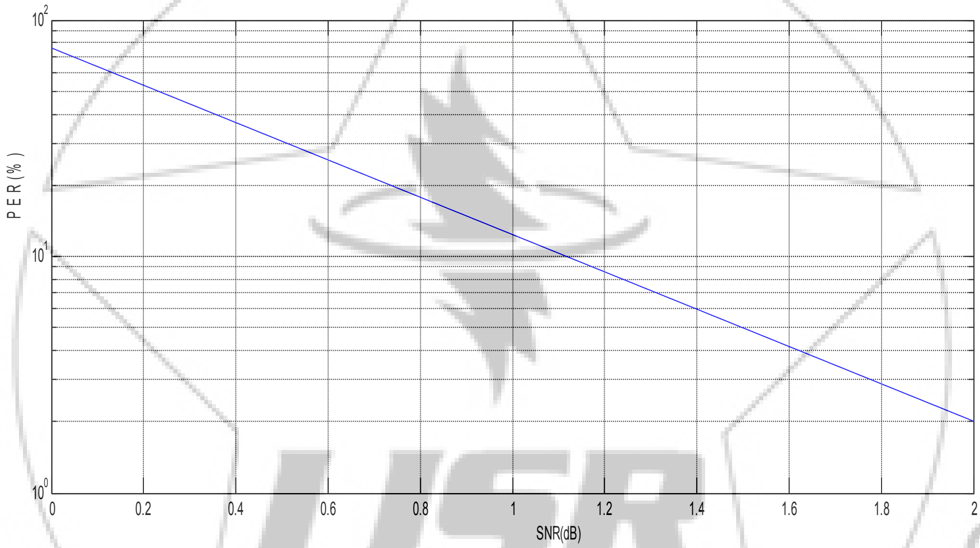

Figure 4: Relation between PER (%) and SNR (dB) when Doppler shift is 50 Hz.

Figure 2, figure 3and figure 4 show the relation between Packet Error Rate (PER) and Signal to Noise Ratio (SNR) for 50, 100 and 150 Hz Doppler shift frequency respectively and AWGN only. While Figures 5, 6, 7 show the results with AWGN and flat fading and 50,100 and 150 Hz Doppler frequency shift

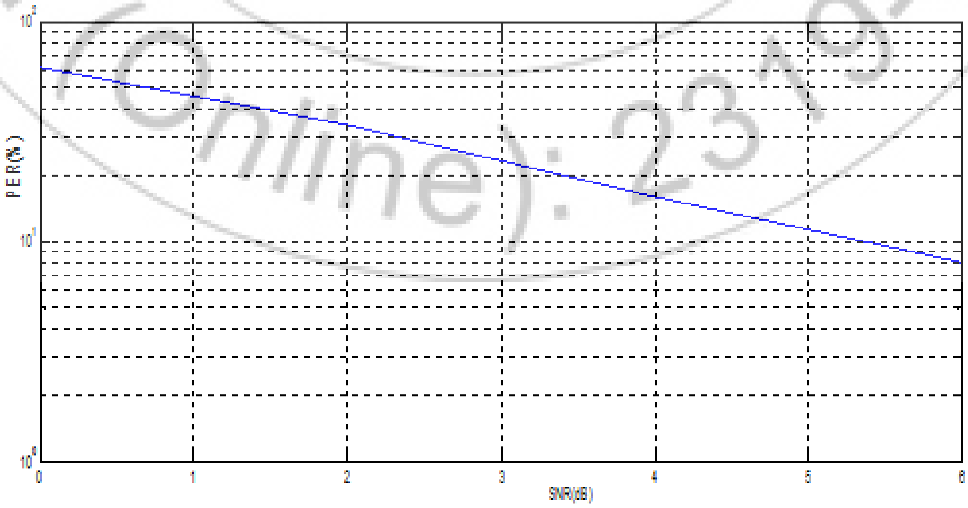

Figure 5: Relation between PER (%) and SNR (dB) when Doppler shift is 50 Hz.

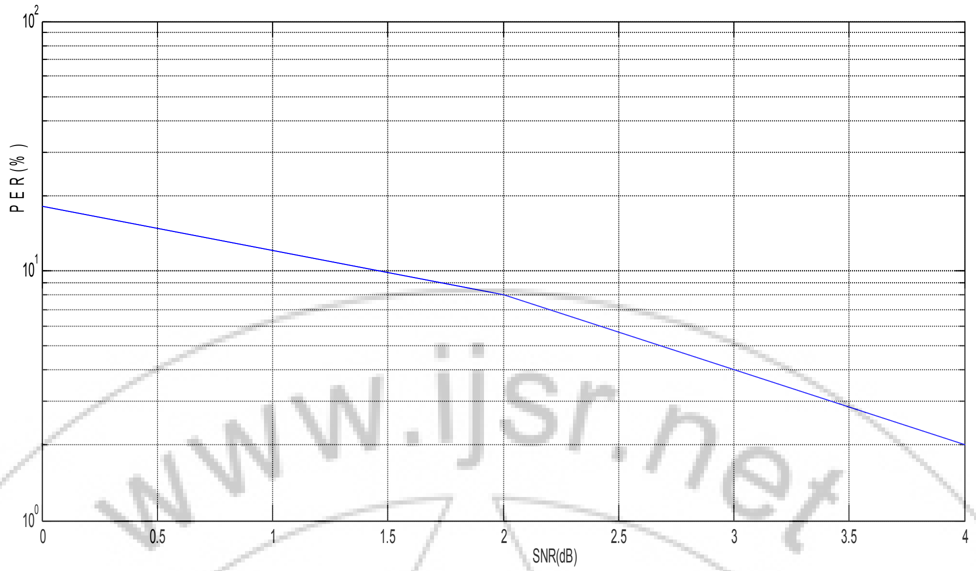

Figure 6: Relation between PER (%) and SNR (dB) when Doppler shift is 100 Hz.

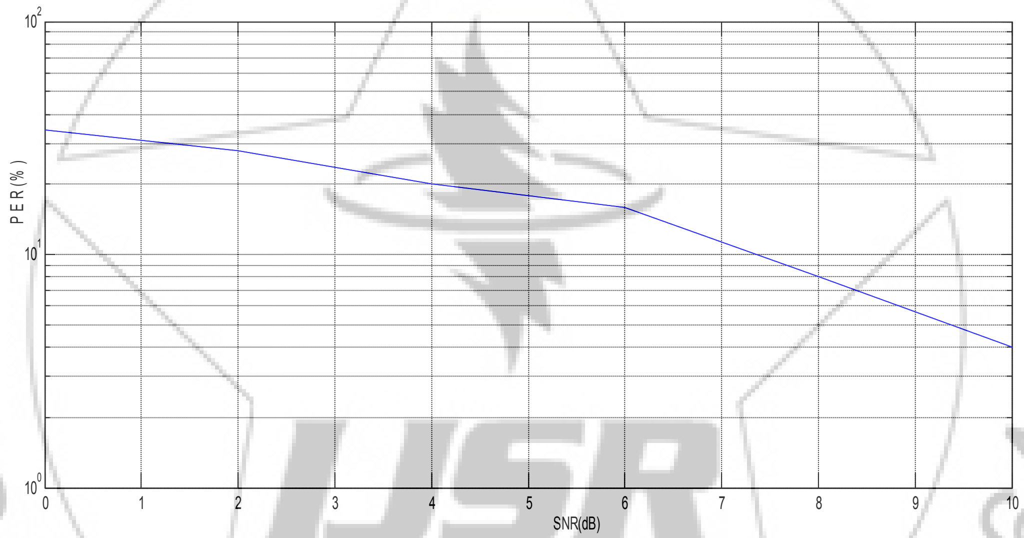

Figure 7: Relation between PER (%) and SNR (dB) when Doppler shift is 150 Hz.

6. Results Discussion

From the results obtained we observe that the PER ratio decreased when SNR increased and the maximum PER ratio was (76%) for zero dB SNR and the minimum value of PER was (2%) ratio for 2dB SNR.

The PER is constant for all values of Doppler frequency shift for AWGN only, while the PER varies with Doppler frequency shift for AWGN and flat fading with a maximum ratio for RER of (62%) at zero dB SNR at 50Hz Doppler frequency shift, and the minimum ratio (8%) occurred when SNR value equal 6 dB. while the PER is maximum value of (18%) for 100 HZ Doppler frequency shift and zero dB SNR, and the minimum value for PER of (2%) when SNR equal 4 dB.

For 150 Hz Doppler frequency shift, the maximum PER (34%) results when SNR value equal zero dB and the minimum ratio results (4%) when SNR value was 10 dB.

7. Conclusion

The performance evaluation of Wi-Fi network have been explored for different Doppler frequency shift ,AWGN and Flat fading using Matlab simulink software program in term of PER ratio versus SNR. Doppler frequency shift are not affected in the performance when the network under AWGN only, while it affected in the performance when the network under AWGN and flat fading. In the future we recommend studying how to reduce the degradation of the network performance in order to reach the best Quality of Service (QoS) for Wi-Fi network.

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