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ANALYSIS OF IEEE 802.11G BASED PHY

Vaibhav jain[1]

Mtech scholar OIMT DAMOH

Mr. AnandSwaroop khare[2]

H.O.D. EC Department OIMT DAMOH

Dr.Sourabhkumarjain[3] ,

Prof. & Head EX Deptt OIMT DAMOH

Abstract

The transmitter first codes and pre-processes the user data signal prior to transmission. The Transmitter Interoperations comprise of bit padding, scrambling, convolutional encoding, data interleaving, sub-carrier modulation mapping, pilot sub-carrier addition, and OFDM modulation. Then, the transmitting signal goes through the communication channel. It is the wireless medium that is between the transmitter and receiver, and is modeled by the impulse response of a multipath fading channel and consists of Addictive White Gaussian Noise (AWGN).

Keyword:- modulation, receiver, transmitter

1. INTRODUCTION

THE IEEE 802.11 ARCHITECTURE

The smallest building block of a wireless LAN is a basic service set, which consists of stations that execute the same MAC protocol and compete for access to the same shared wireless medium [1, 2]. A basic service set may be isolated or, connected to a backbone distribution system through an access point (AP), which functions as a bridge and is implemented as part of a station. A central coordination function housed in the access point controls the MAC protocol or the protocol may be fully distributed. The basic service set generally corresponds to a cell. The distribution system can be a switch, wired network, or wireless network. The portal integrates the IEEE 802.11 architecture with a traditional wired LAN. The portal logic is implemented in a device, such as a bridge or router, which is part of the wired LAN and attached to the distribution system. These extensions to the Basic Service Set constitute an Extended Service, in which a distribution system connects two or more basic service sets. Typically, the distribution system is a wired backbone LAN, but it can be any communications network. The extended service set appears as a single logical LAN to the logical link control (LLC) level. The access point is the logic within a station that provides access to the distribution system by providing services in addition to acting as a station.

2 Original IEEE 802.11 PHY

The original IEEE 802.11 provides three different PHY definitions: Frequency Hopping Spread Spectrum (FHSS), Direct Sequence Spread Spectrum (DSSS), and Infrared [2]. Both Frequency Hopping Spread Spectrum (FHSS) and Direct Sequence Spread Spectrum (DSSS) support 1 and 2 Mbps data rates.

2.1 FREQUENCY HOPPING SPREAD SPECTRUM (FHSS)

Frequency Hopping utilizes a set of narrow channels and "hops" through all of them in a predetermined sequence. For example, the 2.4 GHz frequency band is divided into 70 channels of 1 MHz each. Every 20 to 400 msec the system "hops" to a new channel following a predetermined cyclic pattern. There are 3 hopping sequence set with 26 hopping sequences per set. The minimum hope rate is 2.5 hops per second. The 802.11 Frequency Hopping Spread Spectrum (FHSS) PHY uses the 2.4 GHz radio frequency band, operating with at 1 or 2 Mbps data rate. The basic access rate of 1 Mbps uses a two level Gaussian Minimum Shift Keying (GMSK) while the enhanced access rate of 2 Mbps uses a 4 level GMSK.

2.2DIRECT SEQUENCE SPREAD SPECTRUM (DSSS)

The principle of Direct Sequence is to spread a signal on a larger frequency band by multiplexing it with a signature or code to minimize localized interference and background noise. To spread the signal, each bit is modulated by a code. In the receiver, the original signal is recovered by receiving the whole spread channel and demodulating with the same code used by the transmitter. The 802.11 Direct Sequence Spread Spectrum (DSSS) PHY also uses the 2.4 GHz radio frequency band. The basic access rate of 1 Mbps is encoded using Differential Binary Phase Shift Keying (DBPSK) while the enhanced 2 mbps rate is encoded using Differential Quadrature Phase Shift Keying (DQPSK).

2.3 INFRARED

The Infrared PHY utilizes infrared light to transmit binary data either at 1 Mbps (basic access rate) or 2 Mbps (enhanced access rate) using a specific modulation technique for each. For 1 Mbps, the infrared PHY uses a 16-pulse position modulation (PPM). The concept of PPM is to vary the position of a pulse to represent different binary symbols. Infrared transmission at 2 Mbps utilizes a 4 PPM modulation technique. This specification was designed for indoor use only.

2.4 IEEE 802.11b PHY

PHY of IEEE 802.11b is known as High Rate, direct sequence spread spectrum (HR-DSSS). In addition to 1 and 2 Mbps data rate, IEEE 802.11b provides higher data rates of 5.5 and 11 Mbps. To provide the higher data rates, 8-chip complementary code keying (CCK) is employed as modulation scheme. The chipping rate is 11MHz, which is same as the DSSS system of IEEE Std 802.11, 1999 Edition, thus providing the same occupied channel bandwidth. The basic new capability described in this clause is called High Rate Direct Sequence Spread Spectrum (HR/DSSS) [3]. There is an optional mode replacing CCK modulation with packet binary convolutional coding (PBCC). This mode is denoted as HR/DSSS/PBCC. Another optional mode is provided that allows data throughput at the higher rates (2, 5.5, and 11 Mbps) to be significantly increased by using a shorter PLCP preamble. This mode is called HR/DSSS/short or HR/DSSS/PBCC/short [3].

Four modulation formats and data rates are specified for the High Rate PHY. The basic access rate shall be based on 1 Mbps DBPSK modulation. The enhanced access rate shall be based on 2 Mbps DQPSK. The extended direct sequence specification defines two additional data rates. The High Rate access rates shall be based on the CCK modulation scheme for 5.5 Mbps and 11 Mbps. An optional PBCC mode is also provided for potentially enhanced performance.

3.SIMULATION RESULTS

3.1 INTRODUCTION

In this chapter we report the simulation results for various mandatory and optional modes for IEEE 802.11g. In IEEE 802.11g OFDM is used for 6, 9, 12, 18, 24, 36, 48, and 54 Mbps data rates. Among these 6, 12, and 24 mbps modes are mandatory. The simulation results in presence of AWGN for the mandatory modes and optional modes are shown first. The CCK is used for 5.5 and 11 Mbps mandatory modes. Results for these CCK modes will be presented later. The simulation results are in the form of SNR v/s BER plots for all modes in presence of AWGN and multipath fading channel.

3.2 OFDM MANDATORY MODES

In this section we give results for OFDM mandatory modes. Firstly we give the results showing comparison between all these modes in AWGN channel. Then the effect of multipath fading channel on each mode is presented.

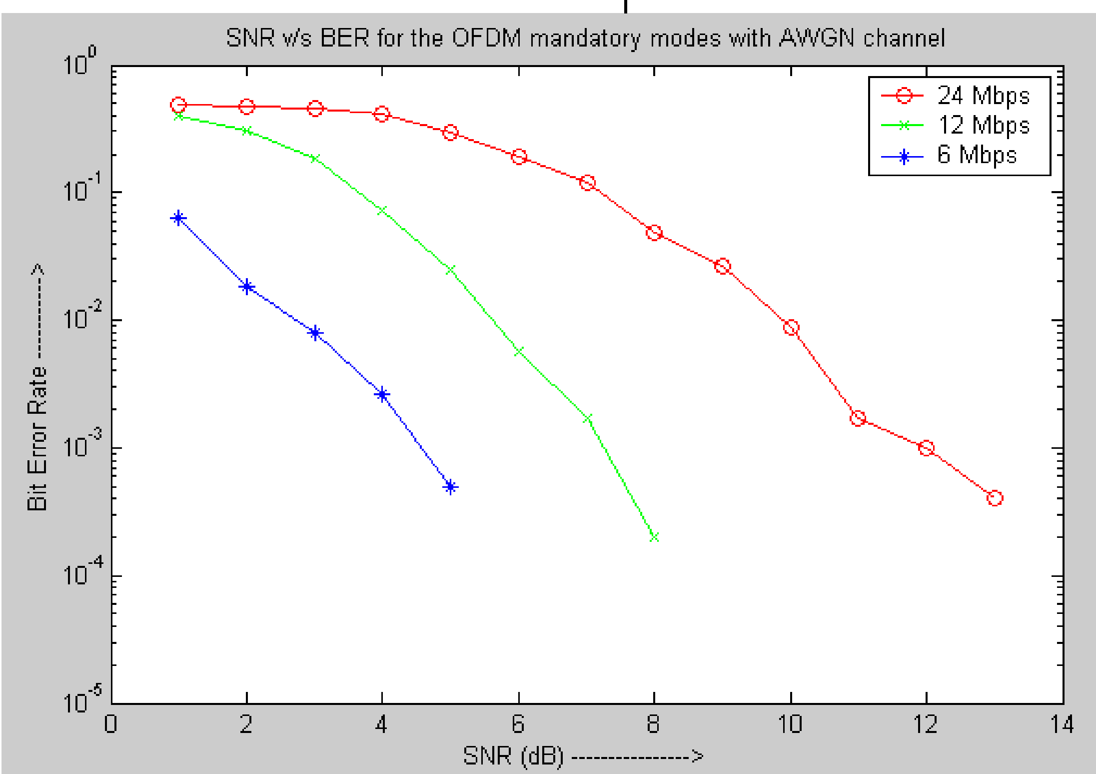

Fig. 3.1 Performance of Mandatory OFDM Modes in AWGN Channel

Fig. 3.1 shows the performances of 6, 12 and 24 Mbps mandatory modes in presence of Additive white Gaussian noise channel. These results are for single path only. The effect of multipath is not considered in this case. For this analysis 50Kbits were transmitted. From the results it is clear that as the data rate increases the performance becomes poorer.For BER of 10^{-3} SNR are approximately 4, 7 & 12 dB respectively for 6, 12 & 24 Mbps.

3.2.1 PERFORMANCE OF 6 MBPS DATA RATE MODE

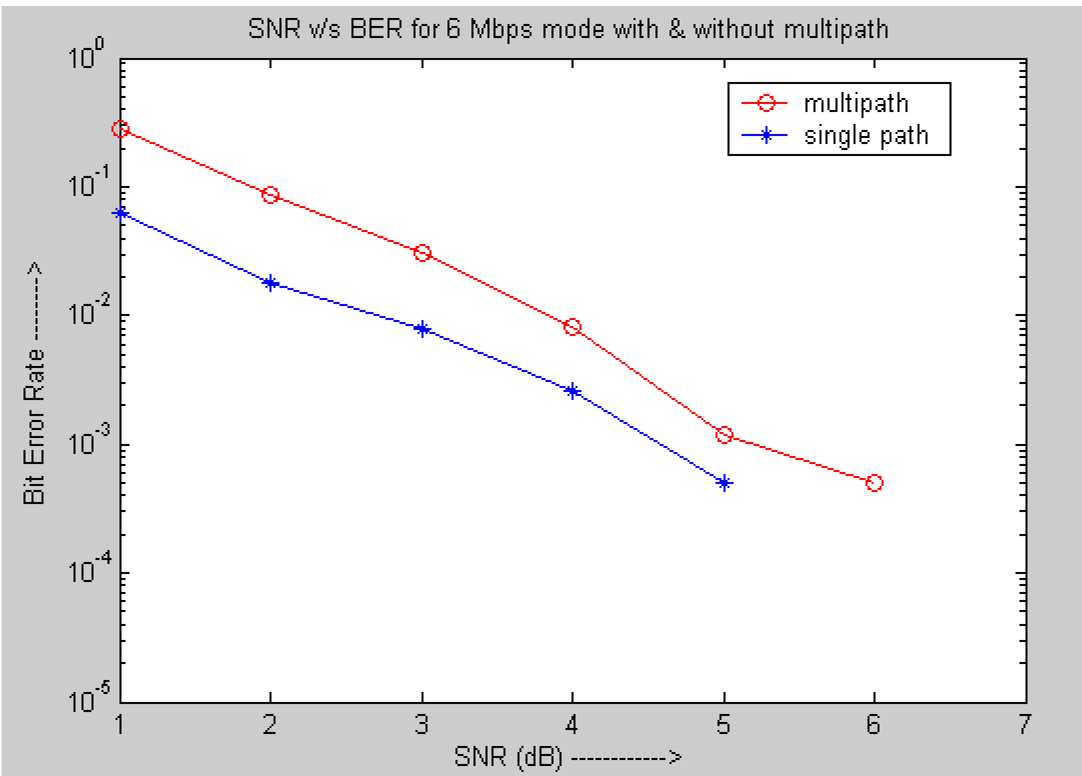

Fig. 3.2 Comparison of Performances of 6 Mbps Mode in Rayleigh Fading Channel with AWGN Channel.

Fig. 3.2 shows the effect of multipath fading on the performance of 6 Mbps mandatory mode. The effect of multipath is to decline the performance further to that of due to AWGN channel. For this analysis 50Kbits were transmitted. Upper curve is obtained when Rayleigh multipath fading channel with AWGN is taken and the lower one is obtained when only single path is considered with AWGN only. Difference is approximately 1dB for 10^{-3} BER between two curves.

3.2.2 PERFORMANCE OF 12 MBPS DATA RATE MODE

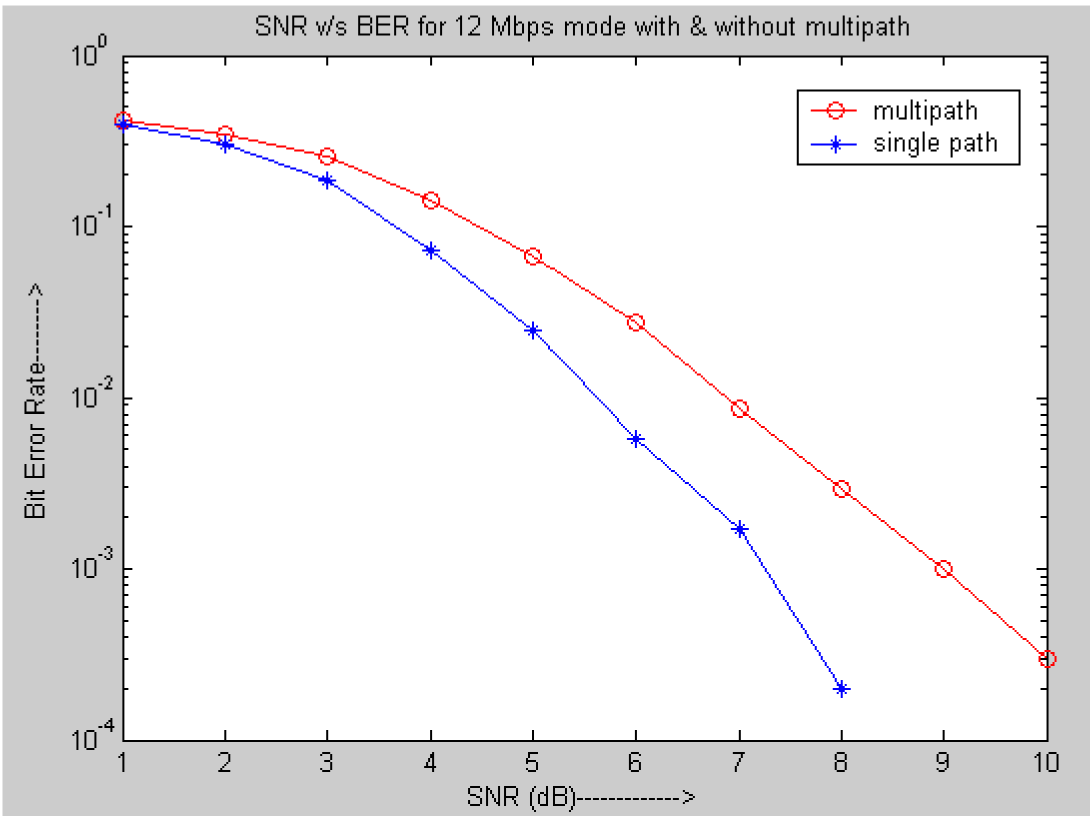

Fig. 3.3 Comparison of Performances of 12 Mbps Mode in Rayleigh Fading Channel with AWGN Channel.

Fig. 3.3 shows the effect of multipath fading on the performance of 12 Mbps mandatory mode. The effect of multipath is to decline the performance further to that of due to AWGN channel. For this analysis 50Kbits were transmitted. Upper curve is obtained when Rayleigh multipath fading channel with AWGN is taken and the lower one is obtained when only single path is considered with AWGN only. If we look at the 10^{-3} BER

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for single path it is obtained at approximately 7 dB SNR and for multipath channel it is obtained at approximately 9 dB SNR.

3.2.3 PERFORMANCE OF 24 MBPS DATA RATE MODE

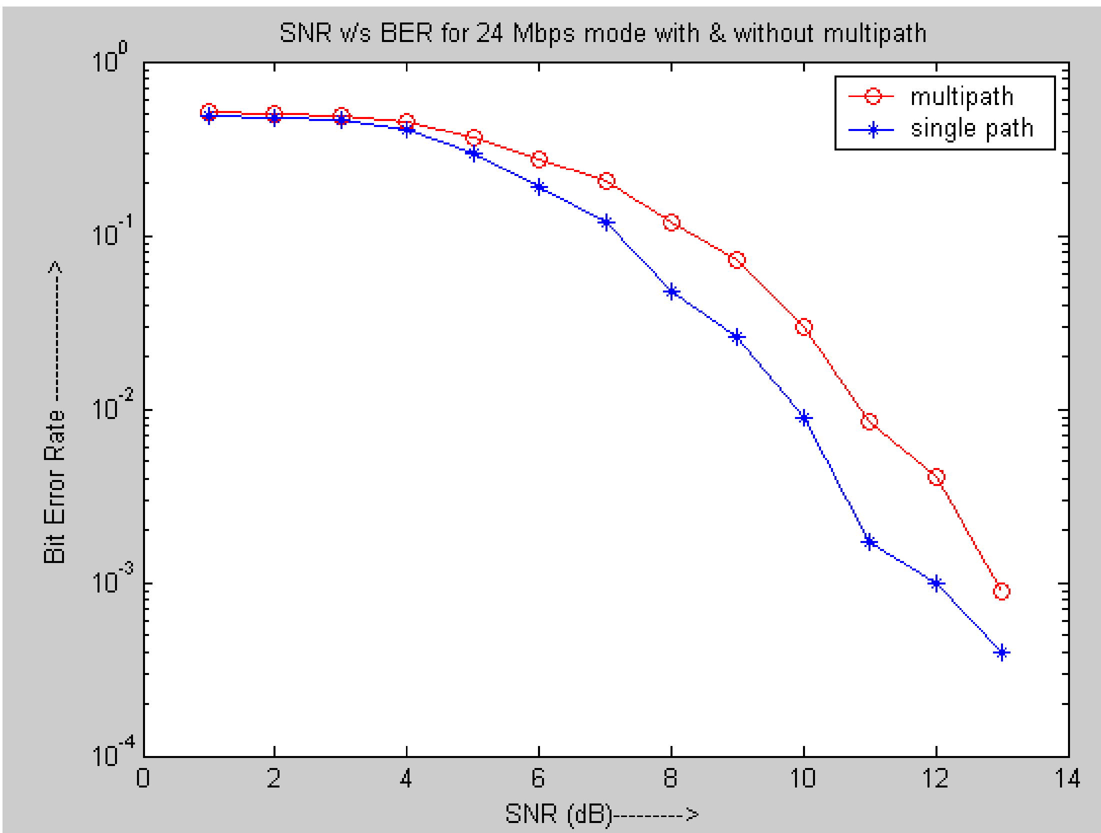

Fig. 3.4 Comparison of Performances of 24 Mbps Mode in Rayleigh Fading Channel with AWGN Channel.

Fig. 3.4 shows the effect of multipath fading on the performance of 24 Mbps mandatory mode. The effect of multipath is to decline the performance further to that of due to AWGN channel. For this analysis 50Kbits were transmitted. Upper curve is obtained when Rayleigh multipath fading channel with AWGN is taken and the lower one is obtained when only single path is considered with AWGN only.

4.CONCLUSIONS

In this thesis first we have studied the basics of wireless local area networks (WLANs).Then the architecture, and the protocol layers of WLAN std. IEEE 802.11 have been studied. This thesis also discusses different Wireless LAN standards and PHY specifications of different WLAN standards. The PHY of IEEE 802.11g has been discussed in detail including transmitter and receiver structure and communication channel.

We have discussed the different operational modes of IEEE 802.11g PHY, End to end communication structure for ERP OFDM modes, Transmitter processes as scrambling, convolutional encoding, data interleaving, modulation mapping, OFDM, the communication channel and noise for the WLANs. Receiver processes have also discussed in brief.

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[5] Multiband Atheros Driver for WiFihttp://www.madwifi.org

[6] NCTUns network simulator and emulator http://nsl10.csie.nctu.edu.tw/

[7] Omnet++ Simulator, http://www.omnetpp.org/

[8] Pythagor simulatorhttp://www.icsd.aegean.gr/telecom/ Pythagor/

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