INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume3, Issue5)
Available online at www.ijariit.com

Performance Estimation of OFDM in Multipath Rayleigh Fading Channel

Pavan Kumar Tiwari
M. Tech Student
BIT Gorakhpur
pavantiwativit@gmail.com

Arun Kumar Mishra
Dean ECE Deptt.
BIT Gorakhpur
akmishra506@rediffmail.com

***Abstract:** In recent years high speed wireless data communications have increasingly been used in many application areas like Orthogonal Frequency Division Multiplexing (OFDM) .The principles of OFDM modulation have been in theory for a long time. But in recent years, this technology has crossed the limitations into the real world of modern communication systems to combat Inter-Symbol Interference (ISI) through multicarrier modulation. OFDM has proved to be very effective in mitigating adverse multipath effects of a broadband wireless channel. Counteracting the frequency selectivity of multipath channels by multiplexing information on different orthogonal carriers is the key to the OFDM success. In this research work, the aim is to figure out the way, for improving the performance of transmitting information. Various kinds of modulation techniques will be studied in terms of their performance in a virtual Rayleigh Channel environment. The average BER performance for different MPSK and M-QAM will be evaluated and use of gray coded bit mapping for different modulation schemes to get BER performance with OFDM technique The numerical results are computed and plotted for M=16 and 64.*

***Keywords:** OFDM, Rayleigh, Modulation, BER, Multipath, Fading Channel.*

I. INTRODUCTION

Orthogonal frequency-division multiplexing (OFDM) is the modulation technique for European standards such as the Digital Audio Broadcasting (DAB) and the Digital Video Broadcasting (DVB) systems. Orthogonal frequency-division multiplexing (OFDM) is a method of encoding digital data on multiple carrier frequencies. The data are sent over parallel sub-channels with each sub-channel modulated by a modulation scheme such as BPSK, QPSK, and 16 QAM etc. The advantage of OFDM is its ability to cope with severe channel conditions compared to a single carrier modulation scheme but still maintaining the data rates of a conventional scheme with the same bandwidth. As such it has received much attention and has been proposed for many other applications, including local area networks and personal communication systems. OFDM is a type of multichannel modulation that divides a given channel into many parallel sub-channels or subcarriers so that multiple symbols are sent in parallel. Furthermore, channel equalization is simplified because OFDM may be viewed as using many slowly modulated narrowband signals rather than one rapidly modulated wideband signal. Also, the low symbol rate naturally makes the use of guard interval between symbols reducing ISI. Orthogonal Frequency Division Multiplexing has become one of the mainstream physical layer techniques used in modern communication systems.

The first OFDM schemes were presented by [8] and [9]. The actual use of OFDM was limited and the practicability of the concept was questioned the choice for OFDM as transmission technique could be justified by comparative studies with single carrier systems. OFDM is often motivated by two of its many attractive features: it is considered to be spectrally efficient and it offers an elegant way to deal with equalization of dispersive slowly fading channels.

II. LITERATURE SURVEY

Orthogonal frequency-division multiplexing (OFDM) is a method of digital modulation in which a signal is split into several narrowband channels at different frequencies [11]. In OFDM the signal itself is first to split into independent channels, modulated by data and then re-multiplexed to create the OFDM carrier. Therefore, OFDM is a combination of modulation and multiplexing. OFDM is a multi-carrier transmission technique [6], which divides the available spectrum into many carriers, each one being modulated by a low rate data stream. In some respects, OFDM is similar to conventional Frequency Division Multiplexing (FDM) in that the multiple user access is achieved by subdividing the available bandwidth into multiple channels, that are then allocated

to users. The difference lies in the way in which the signals are modulated and demodulated. However, OFDM uses the spectrum much more efficiently by spacing the channels much closer together.
This is achieved by making all the carriers orthogonal to one another, preventing interference between the closely spaced carriers. The below figure shows the comparison between the conventional FDM and OFDM.

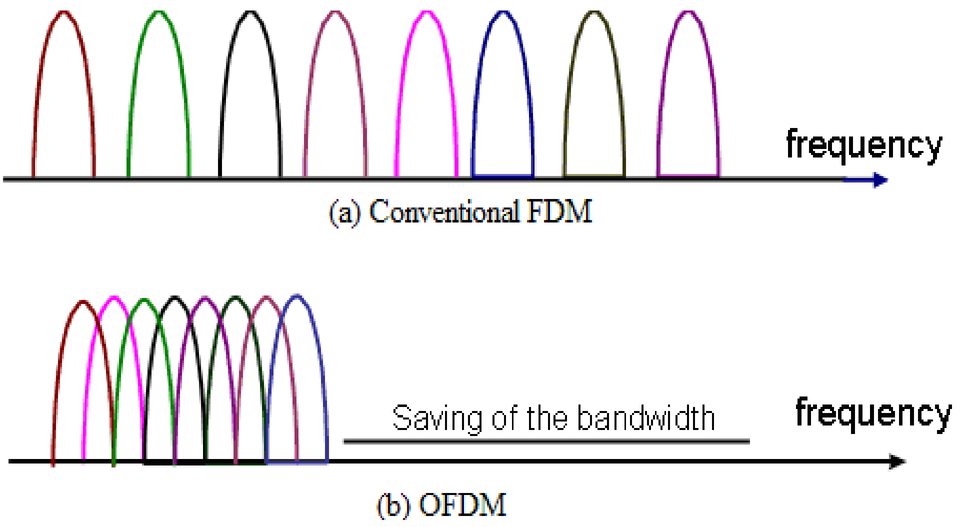

Figure 1: FDM and OFDM

OFDM results in an improved downlink multimedia services require high data rates communications, but this condition is significantly limited by inter-symbol interference (ISI) due to the existence of the multiple paths, for which multi-carrier OFDM has been seen as a suitable option. Wireless medium is quite different from the counterpart using wires and provides several advantages, for example; mobility, better productivity, low cost, easy installation facility, and scalability.

A number of researchers have been done for usability of OFDM in various fading channels. In [1] Mohammed S. Akhoirshida et.al have analyzed the performance of OFDM- BPSK, the system by using forward error correcting codes (convolutional, reed Solomon as well as concatenated coding) schemes that are used to encode the data stream in wireless communications AWGN channel has been reported here. The authors have presented OFDM for wireless communications.They address basic OFDM and related modulations, as well as techniques to improve the performance of OFDM for wireless communications (OFDM). The various simulations have been done to find out the best BER performance of each of the Convolutional and Reed-Solomon codes and used these best outcomes to model the RS-CC concatenated codes.

In [2], Jun Lu has considered a space-time coded (STC) orthogonal frequency-division multiplexing (OFDM) system with multiple transmitter and receiver antennas over correlated frequency and time-selective fading channels. It is shown that the product of the time-selectivity order and the frequency-selectivity order is a key parameter to characterize the outage capacity of the correlated fading channel. They have observed that STCs with large effective lengths and ideal built-in interleaves are more effective in exploiting the natural diversity in multiple antennae correlated fading channels. In [3], Y.J Ryu et.al have proposed A timing offset estimator robust to a Rayleigh fading channel and a fast Fourier transform (FFT) window selection algorithm that can remove inter-symbol interference (ISI). The use of amplitude information in the proposed algorithm means that the influence of distorted pilots due to fading becomes insignificant when estimating a timing offset. The proposed FFT window selection algorithm based on the cyclic extension property of the OFDM structure can remove the ISI problems caused by multipath fading channels, thereby significantly improve the receiver performance without any additional computational requirements. The paper uses the DVB-T standard to evaluate the algorithms.
In [4-7] and [10], Nagakami m-fading channel and the various methods to improve BER performance in it, have been presented. Error rates of orthogonal frequency-division multiplexing (OFDM) signals in multipath slow fading Nagakami-m fading channels are considered. The exact probability density function of a sum of Nagakami-m random phase vectors is used to derive a closed-form expression for the error rates of OFDM signals. In [6], M. K. Mishra et. al, have proposed that average BER expressed in terms of the higher transcendental function such as the confluent hypergeometric functions. The numerical results show that depending on the number of channel taps, the BER performance may degrade with increasing values of Nakagami–m fading parameters.

In [8], Zhangyong Ma, a novel scheme has been proposed for joint carrier frequency offset and channel estimation in a Rayleigh flat-fading channel. A simple time-domain weighted algorithm based channel estimation with the pilot-data multiplexed scheme is investigated. The simulation results show that the proposed methods achieve a more accurate estimation of the CFO and the time-variant channel parameter than the conventional schemes, and the system performance is improved dramatically.

In [9], SONG Lijun et. al. have studied the performance of frequency domain differential demodulation(FDDD). The bit error rate (BER) performance of for orthogonal frequency division multiplexing system has been evaluated by computer simulation and compared with the time domain differential demodulation(TDDD). The results indicate that the performance of FDDD is better than that of TDDD, and the lower band of BER in the former is lower than that of the latter.

III.PROPOSED WORK

There are some restrictions and disadvantages of various transmission channels in the wireless medium between receiver and transmitter where transmitted signals arrive at the receiver with different power and time delay due to the reflection, diffraction, and scattering effects. Besides the BER (Bit Error Rate) value of the wireless medium is relatively high. These drawbacks sometimes introduce destructive effects on the wireless data transmission performance. As a result, error control is necessary for these applications. During digital data transmission and storage operations, performance criterion is commonly determined by BER which is simply: Number of error bits / Number of total bits. Noise in transmission medium disturbs the signal and causes data corruptions. The relation between signal and noise is described with SNR (signal-to-noise ratio). Generally, SNR is explained with signal power/noise power and is inversely proportional with BER. It means, the less the BER result is the higher the SNR and the better communication quality.

This research work is motivated and aimed at carrying out a similar study and analysis for the performance of various popular modulation schemes in a Rayleigh Fading Channel.

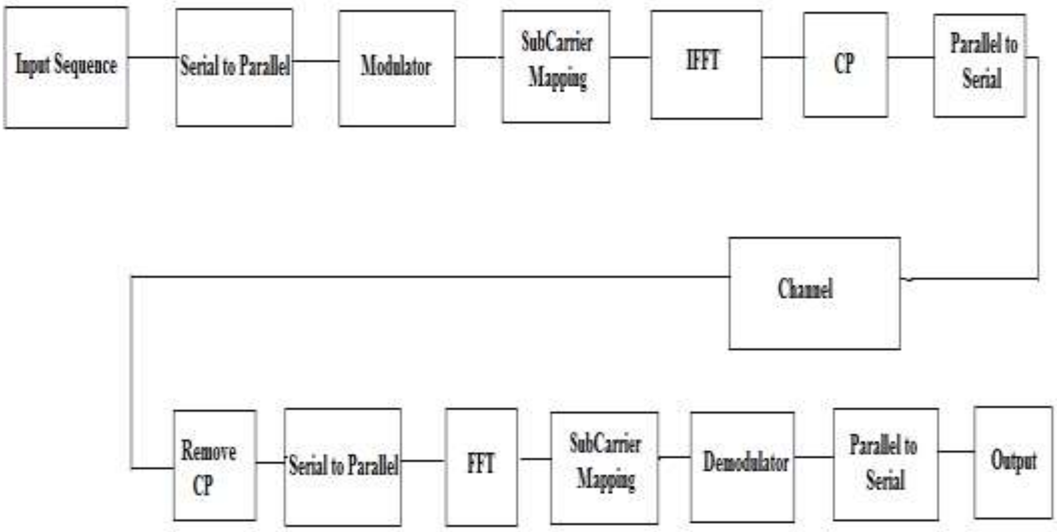

Figure 2: System Architecture

The system architecture implemented for this research work is shown in figure 2. a random bit generator to generate a random bit stream. The output is a 1-dimensional array of bits. We then perform a serial-to-parallel conversion sending the bits on parallel streams each representing a subcarrier. The series to parallel conversion is done to allow the bitstream generated in the previous step to the various subcarriers. The number of subcarriers is taken to be 512. Thus the input bitstream is divided into 512 parallel bitstreams. Various modulation schemes have been used on all the subcarriers. The modulation schemes have been used and the results have been simulated. BPSK, QPSK, 16QAM, 64 QAM are the various modulation schemes which have been used. The mapping of subcarriers is the next step to align the bit stream over the subcarriers. IFFT of all the parallel data streams together ensuring orthogonally between the subcarriers and the conversion of symbols to the time domain.

$$x(n) = \frac{1}{N}\sum_{k=0}^{N-1} X(k).e^{j(\frac{2\pi}{N})nk} \quad ; (n=0,1,\ldots.N-1) \qquad (1)$$

Where, X(k) is a complex frequency domain data sent on subcarriers of frequency k/N, k=0,1,….,N
k/N term is orthogonal to every other value of k/N.

Cyclic prefix addition is the next step of the procedure. The term cyclic prefix refers to the prefixing of a symbol with a repetition of the end. The cyclic prefixed bitstream is now converted back to serial bit stream to be transmitted over the channel. Rayleigh channel model has been used as the fading channel for this research work. The Rayleigh channel is implemented using the built-in function. The cyclic prefix added at the time of transmission is removed in this step. This is the first step at the receiving end. The serial bit stream is converted to parallel data and is mapped onto the respective subcarriers. Fast Fourier Transform is used to convert the signal to Fourier domain to make the analysis easier. Built-in functions is used to convert the data stream into Fourier domain. The subcarrier mapping is used to map the subcarriers with the respective bit stream pattern on them. The demodulator demodulates the bitstream, so as to retrieve the original or baseband signal. According to the type of modulation, using the corresponding demodulation method is applied. The parallel data is then converted back to serial bit pattern to retrieve the message which is the final output.

IV. SIMULATION AND RESULTS

MATLAB R2010a has been used to program and simulate the complete environment. The various parameters have been initialized and various built-in functions have been used to implement the complete design of the system.

TABLE 1: SIMULATION PARAMETERS

Parameter	**Value**
Number of Subcarriers	512
FFT Length	512
Bandwidth	$5x10^6$
Sampling Frequency	2xBW
Cyclic Pad Length	64 bits
Modulation Technique	BPSK, QPSK, 16QAM, 64 QAM

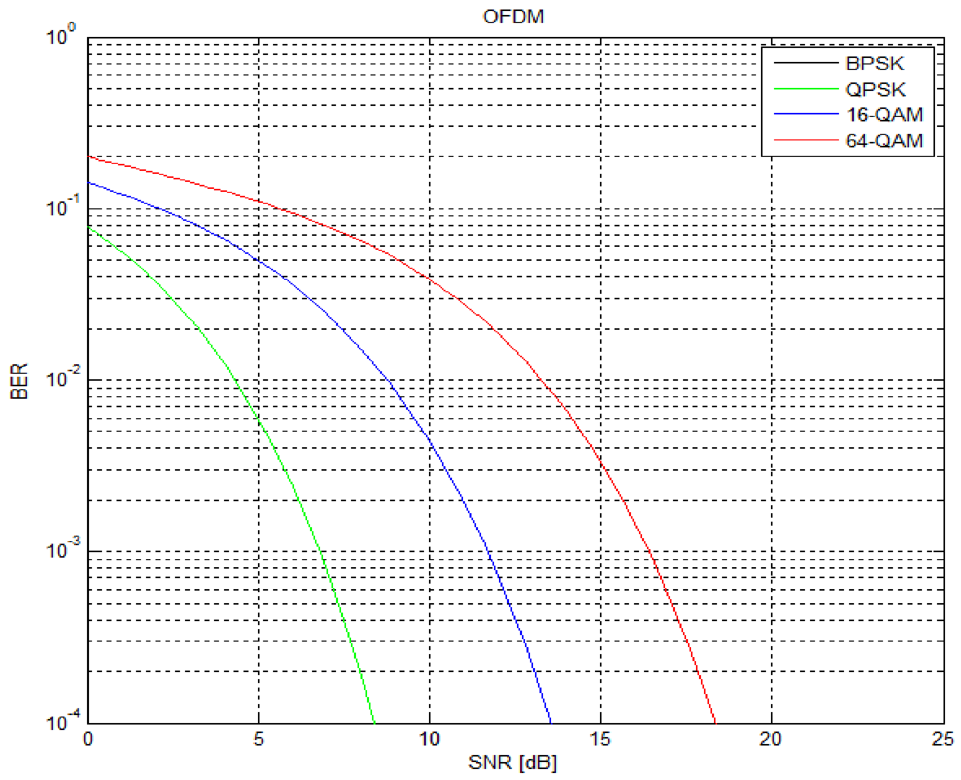

Figure 3: BER vs SNR plot

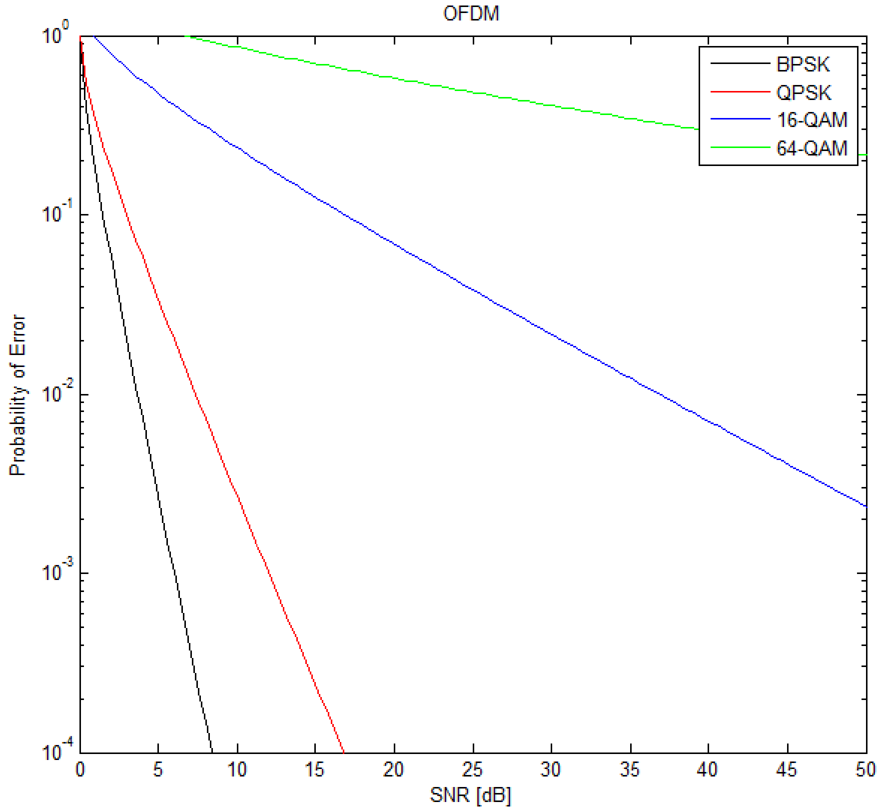

Figure 4: Probability vs SNR plot

Figure 3 shows the BER vs SNR plot for various modulation techniques which have been used in this research work. The 64 QAM modulation technique shows better performance over Rayleigh Channel. Figure 4 shows the Probability of error graph against SNR. This graph shows the bandwidth performance of OFDM under Rayleigh channel for various modulation techniques.There always exists a tradeoff between the bandwidth efficiency and BER vs SNR performance.

CONCLUSION

In this research work, the OFDM model of Wireless Communication is implemented and a number of modulation schemes are used viz. BPSK, QAM, QPSK, 16PSK, etc. The various performance parameters like BER, SNR etc. are to be evaluated. The channel used is Rayleigh fading Channel, for this research. The research work is intended to study and analyze the performance of OFDM technique under various modulation schemes. The MATLAB software which will be used for the implementation of this research work contains a wide range of functions to study, analyse and simulate the various kinds of the communications system. This research work studies the results of a Rayleigh fading channel, which is the most widely researched models of fading channels.

REFERENCES

[1] Mohammed S. Akhoirshida and Mustafa M. Matalgah--BER Performance Analysis of Interference-Limited BPSK Cooperative Communication Systems with Cochannel Interference in Nakagami-m Fading Channels, PAWR 2013, IEEE.

[2] Jun Lu, Thiang Tjhung, Fumiyuki Adachi and Cheng Li Huang, ―BER performance of OFDM-MDPSK system in Frequency –Selective Rician Fading with Diversity Reception,|| IEEE Trans. On Vehicular Technology, vol. 49, no. 4, pp. 1216-1225, July 2000.

[3] Young Jae Ryu and Dong Seog Han, ―Timing phase estimator overcoming Rayleigh Fading For OFDM systems,‖ IEEE Proc., pp. 66- 67.

[4] M. Nakagami, ―The m-distribution—A general formula of intensity distribution of rapid fading,‖ in Statistical Methods in Radio Wave Propagation, W. C. Hoffman, Ed. Elmsford, NY: Pergamon, 1960.

[5] Zhein gjiu Kang, Kung Yao, Flavio Lorenzelli, ―Nakagami-m Fading Modeling in the Frequency Domain for OFDM system analysis,‖ IEEE Communication letters, vol. 7, no.10, pp. 484-486, Oct.2003.

[6] Zheng du, Julian Cheng and Norman c. Beaulieu, ―Asymptotic BER performance of OFDM in Frequency Selective Nakagami-m Channels,‖ IEEE Conference on Vehicular Technology, vol. 1, pp. 612-615, Sept. 2004.

[7] Zheng du, Julian Cheng and Norman c. Beaulieu, ―Accurate Error Rate Performance Analysis of OFDM on Frequency-Selective Nakagami-m Fading Channels,‖ IEEE Trans.on communications.vol. 54, no. 2, pp. 319-328, Feb. 2006.

[8] Zhangyong Ma and Young-il- Kim, ―A Novel OFDM receiver in Flat Fading Channel,‖ IEEE Conference on advanced communication technology, ICACT, Vol.. 2, pp. 1052-54, 2005.

[9] SONG Lijun, TANG Youxi, LI Shaoqian and HUANG Shunji, ―BER Performance of Frequency Domain Differential Demodulation OFDM in Flat Fading Channel,‖ Journal of Electronic Science and Technology of China, Vol. 1, no. 1, Dec. 2003.

[10] Jyoteesh Malhotra, Ajay K. Sharma, R.S Kaler, ―Investigation on First Order Performance Metrics in the Nakagami-m Fading Channel,‖ In the proceeding of the conference of Design Technique for Modern Electonic Devices, VLSI and Communication Systems, 14th-15th May 2007.
[11] E. Biglicri, J. Proakis, and S. Shamai, "Fading channels: information-theoretic and communications aspects," IEEE Trans. Inform. Theory, vol. 44, no. 6, pp. 2619-2692, Oct. 1998.
[12] M. Patzold, U. Killat, F. Laue, and Y. Li, "On the statistical properties of deterministic simulation models for mobile fading channels," IEEE Trans. Veh. Technol., vol. 47, no. 1, pp. 254-269, Feb. 1998.
[13] J. Frolik, T. Weller, S. DiStasi and J. Cooper, "A compact reverberation chamber for hyper-Rayleigh channel emulation," IEEE Trans. Antennas propag., vol. 57, no. 12, pp. 3962-3968, Dec. 2009.
[14] A. Henderson, G. Durgin, and C. Durkin, "Measurement of small-scale fading distributions in a realistic 2.4 GHz channel."
[15] B. Ai, J. Ge, Y. Wang, S. Yang and P. Liu, "Decimal frequency offset estimation in COFDM wireless communications," IEEE Trans. Broadcasting, vol. 50, no. 2, pp. 154-158, Jun. 2004.
[16] S. Coleri, M. Ergen, A. Puri and A. Bahai, "Channel estimation techniques based on the pilot arrangement in OFDM systems", IEEE Trans. Broadcasting, vol. 48, no.3, pp. 223-229, Sept. 2002.
[17] W. C. Jakes, Ed., Microwave Mobile Communications, New York: IRRR Press, 1974
[18] C. Xiao, Y. Zheng, N. Beaulieu, "Novel sum-of-sinusoids simulation models for Rayleigh and Rician fading channels", IEEE Trans. Wireless Commun., vol. 5, no. 12, pp. 3667-3678, Dec. 2006.
[19] E. Tufvesson, T. Maseng, "Pilot-assisted channel estimation for OFDM in mobile cellular systems," in Proc. IEEE 47th Vehicular Technology Conference, Phoenix, USA, May 1997, pp. 1639-1643
[20] J. Choi, Y. Lee, "Optimum pilot pattern for channel estimation in OFDM systems", IEEE Trans. Wireless Commun., vol. 4, no. 5, pp. 2083-2088, Sep. 2005.
[21] M. J. Fern´andez-Getino Garc´ıa, S. Zazo, and J. M. P´aez-Borrallo, "Pilot patterns for channel estimation in OFDM," Electron. Lett. vol. 36, no. 12, pp. 1049-1050, June 2000.
[22] M. Hsieh, C. Wei, "Channel estimation for OFDM systems based on the comb-type pilot arrangement in frequency selective fading channels," IEEE Trans. Consumer Electron., vol. 44, no. 1, pp. 217-225, Feb. 1998.
[23] Y. Li, "Pilot-symbol-aided channel estimation for OFDM in wireless systems", IEEE Trans. Veh. Technol., vol. 48, no. 4, pp. 1207-1215, Jul. 2000.
[24] J. Moon, S. Choi, "Performance of channel estimation methods for OFDM systems in a multipath fading channels," IEEE Trans. Consum. Electron. vol. 46, no. 1, pp. 161-170, Feb. 2000.

