Volume 2, Issue 11, November 2012 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Performance of OFDMA Based System on Varying Channel Length for Different Modulation Technique

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Abstract*—In these days Wireless Broadband Technologies allow simultaneous delivery of voice, data and video over fixed or mobile platforms. WiMax 4G, Orthogonal Frequency Division Multiplexing (OFDM), Interleave Orthogonal Frequency Division Multiplexing (IOFDM) are some of the emerging broadband technologies. The paper is divided into two parts channel estimation and channel response. In the channel estimation part, estimation of the channel transfer function in the preamble using MLS method is down. The channel length is varying and the Doppler frequency is fixed. The effects of varying channel length are shown on different modulation technique and also seen channel responses. At high SN, both methods reach an error floor due to the residual error produced by the ICI. This paper develop robust and low complexity channel estimation algorithms and compare different modulation technique for OFDMA reuse1 systems, which are in compatible with the IEEE 802.16e standard. In this paper, the effect of varying channel length and the impulse response of the different varying channels for different modulation techniques are shown. We get that, the QAM is better than other used modulation techniques for varying channel length.

***Keywords*— 4G, Wireless, OFDM, Modulation, channel estimation, channel width, Doppler frequency.**

I. INTRODUCTION

In wireless communications, 4G is the fourth generation of mobile communications standards. A 4G system provides mobile ultra-broadband Internet access, for example to laptops with USB wireless modems, to smart phones, and to other mobile devices. Its applications mobile web access, IP telephony, gaming services, high-definition mobile TV, video conferencing and 3D television. One main advantage of 4G is that it can at any point of travelling time provide an internet data transfer rate higher than any existing cellular services. [1]

In previous few years, new access schemes like Orthogonal FDMA (OFDMA), Single Carrier FDMA (SC-FDMA), Interleaved FDMA and Multi-carrier CDMA (MC-CDMA) are gaining more importance for the next generation systems.

Research on the development of 4th generation (4G) mobile communication systems is going on and in 2013 it will be launched in China. 4G networks should encompass broadband wireless services, such as High Definition Television (HDTV) (4 - 20 Mbps) and computer network applications (1 - 100 Mbps). This will allow 4G networks to replace many of the functions of WLAN systems. However, to cover this application, cost and complexity of service must be reduced significantly from 3G networks. The spectral efficiency of 3G networks is too low to support high data rate services at low cost. As a consequence one of the main focuses of 4G systems will be to significantly improve the spectral efficiency supporting the high data rates with sufficient robustness to radio channel impairments, require careful choosing of modulation technique. OFDM is a robust efficient modulation scheme for broadband communications. It combats multipath fading and narrow band interference efficiently.[1] OFDMA, multiple access scheme based on OFDM, has lots of flexibility and when coupled with feedback information it can achieve high data rates efficiently. The wireless MAN-OFDMA is one of the air interface standard for NLOS communication.

II. BASIC THEORY OF CHANNEL ESTIMATION

A communication channel can be either to a physical transmission medium such as a wire or Wireless transmission. The communication channel mean: medium through which a message is transmitted from the transmitter to the receiver. Unlike wired channels that are stationary and deterministic, wireless channels are extremely random in nature. Some of the features of wireless communication like mobility, place fundamental limitations on the performance in a wireless system. The line-of-sight (LoS) to one that is severely obstructed by buildings, terrain and foliage will be varying in the transmission path between transmitter and receiver. For coherent detection and decoding the efficient channel estimation strategies are required. Channel stimates are used in diversity techniques like Maximal Ratio combining. The channel estimate is feedback to the transmitter in opportunistic communication systems. The transmitter uses the channel knowledge to exploit Multi User Diversity (MUD). Therefore, the channel estimator is inevitable in any wireless communication system.[5]

A channel model can be thought of as a mathematical representation of the transfer characteristics of the physical medium. This model could be based on some known underlying physical phenomenon or it could be formed by fitting the best mathematical model on the observed channel function. Most of the channel models are formulated by observing the characteristics of the received signals for each specific environment. Different mathematical models that explain the received signal are fit over the accumulated data. The one that best explains the behavior of the received signal is used to model the given physical channel.

Channel estimation is simply defined as the process of characterizing the effect of the physical channel on the input sequence. For linear channel, the channel estimation is simple of the impulse response of the system. It must be stressed once more that channel estimation is only a mathematical representation of what is truly happening.

III. ADVANTAGES OF CHANNEL ESTIMATION

Channel estimation algorithms allow the receiver to approximate the impulse response of the channel and explain the behavior of the channel. This knowledge of the channel's behavior is well-utilized in modern radio communications. Adaptive channel equalizers utilize channel estimates to overcome the effects of inter symbol interference. Diversity techniques (for e.g. the IS-95 Rake receiver) utilize the channel estimate to implement a matched filter such that the receiver is optimally matched to the received signal instead of the transmitted one. Maximum likelihood detectors utilize channel estimates to minimize the error probability. One of the most important benefits of channel estimation is that it allows the implementation of coherent demodulation.Coherent demodulation requires the knowledge the phase of the signal. This can be accomplished by using channel estimation techniques.[11]

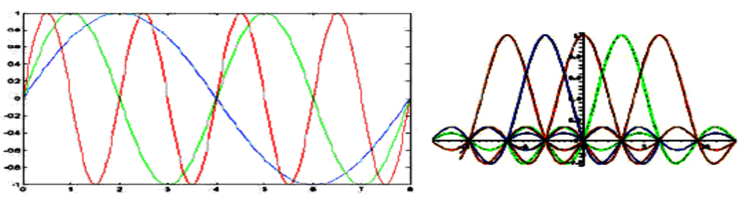
The channel estimation in OFDMA can be widely classified into two categories.

1. Pilot Based channel Estimation: known symbol called pilots are transmitted.

2. Blind Channel Estimation Methods: No pilots are required. It uses some underlying mathematical properties of data sent. The Blind channel estimation methods are computationally complex and hard to implement. The Pilot based channel estimation methods are easy to implement, but they reduce bandwidth efficiency.

IV. ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING (OFDM)

In the scenario of high bit rate digital communications over wireless channels, one often has to deal with transmission channels that exhibit a phenomenon known as fading or a highly time-varying frequency response over the signal bandwidth.[4] This fading occurs over wireless transmission media primarily because the signal in such media is transmitted across multiple paths of varying attenuation and delay spread. In such a system, with the use of single carrier modulation systems, channel equalization turns out to be a very difficult task, especially in the presence of time-varying channels, and the discrepancies in the SNR at different frequencies lead to a low spectral efficiency, or even to a reduction in the useful bandwidth. The idea underlying the adoption of multicarrier modulation systems is that of dividing the available channel band into a very high number of sub-bands (sub channels) , each one so small that the channel frequency response can be assumed to be constant within a single sub-band . The overall information stream is thereby partitioned into corresponding sub streams, each one of them being transmitted over a different sub-channel.[12] By dividing the available bandwidth into several narrowband sub-channels each of which undergoes frequency flat fading, high-rate data is sent through low-rate sub channels in parallel. Also, a cyclic prefix is used to make sub-channels orthogonal to one another so that inter carrier interference (ICI) and inter symbol interference (ISI) are avoided. With these advantages OFDM has been adopted as the standard transmission technology for digital audio broadcasting (DAB) and terrestrial digital video broadcasting (DVB-T) in Europe, and recently for wireless local area networks (WLAN) such as HIPERLAN/2 IEEE 802.11a and IEEE 802.16. It is also one of the promising techniques for the fourth generation (4G) cellular system. Although the theoretical basis for development of OFDM is over 40 years old, it has not been implemented successfully until recently owing to high amount of computational complexity and memory requirements of the receiver for such a system.[3]



(a) (b)

Fig1. Orthogonality of subcarriers (a) Time domain, The number of cycles (b) Frequency domain, the peak of the in Symbol differ by one for adjacent sinc comes at the null of other sinc sub carriers waveforms.

V. SYSTEM MODEL

We derive a linear system model which relates the transmitted OFDM symbol (in frequency domain), 1 2 1 , ,... ,........ − = *k N x x x x x* and the received OFDM symbol 1 2 1 ,.... ,......... − = *k N y y y y y* . Assuming that most of the energy in the impulse response is concentrated in L taps, the channel vector is given by 1 2 , 1 , ,..... 0,..0 *L NX h* = *h h h* . Assume that channel remains constant over one OFDM symbol and L is less than the cyclic prefix.[8]

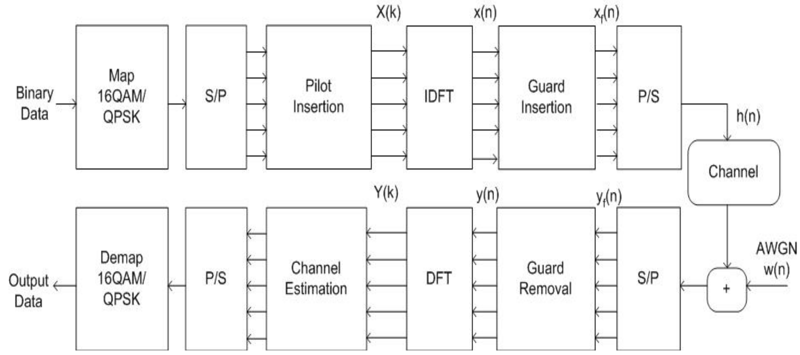


Fig. 2 OFDM System Model

VI. MODULATON TECHNIQUES

Modulation is a process by which some characteristic of a signal called carrier is varied in accordance with modulating signal. Used Modulation technique are-

1. Binary Phase Shift Keying (BPSK)

Less Probability of error.It need a complicated synchronizing ckt at the receiver for generation of local carrier. Ambiguity in the output signal because use square law device in receiver side.

2. Differential Phase Shift Keying (*DPSK)*

DPSK does not need carrier at it receiver. This means that the complicated circuitry for generation of local carrier is avoided. The BW requirement of DPSK is reduced compared to that of BPSK.The probability or error rate of DPSK is higher than that of BPSK. Noise interference in DPSK has more.

3. Quadrature Phase Shift Keying (*QPSK)*

In QPSK for the same bit error rate, the BW required by QPSK is reduced to half as compared to BPSK. Because of reduced BW, the information transmission rate of QPSK is higher. Variation in QPSK amplitude is not much. Hence carrier power almost remains constant.

4. Quadrature Amplitude Modulation (*QAM)*

QAM is somewhat of an exacting scheme. A slight error in the phase or the frequency of the carrier at the demodulator in QAM will not only result in loss and distortion of signals, but will also lead to interference between the two channels.

VII. SIMULATIONS PARAMETERS

A system level simulator, developed in MATLAB, for single cellular, single user environment has been used. [13] The Simulation parameters are shown in the table below:

Table 1. Parameters of taken system

FFT Size	512
Cyclic Prefix	64
Band width	5 MHz
Sampling Frequency	5.712 MHz
Sub Carrier Spacing	11.15 KHz
Useful Symbol Time	90 µs
CP Duration	11.25µs
Downlink	40 symbols
Frame Duration	4 ms

The fading channel is implemented with the Jakes Method (Sum of Sinusoids method). The fading channel model, with power delay profile corresponding to PED B, 1 is used. The channel parameters are listed below. Only sample spaced channels are considered. The non-integer samples of the PDP are mapped to the nearest sample position. The pilots are QPSK modulated and they have unit energy.

Table 2. Taken delays and gain

Number of Taps	6
Tap Delays (in μs)	0, 0.2, 0.8, 1.2, 2.3, 3.7
Relative Tap Gain (in dB)	0, -1, -5, -8, 17.8, -24

VIII. RESULTS

Table 3. For fixed Doppler Frequency =10 Hz and varying Channel Length

Parameter	**Used Modulation Technique**		
Channel Length	**PSK**	**QPSK**	**QAM**
	NMSE in dB	**NMSE in dB**	**NMSE in dB**
6	-38	-42	-45
10	-37	-47	-37
20	-45	-44	-38
40	-33	-38	-39

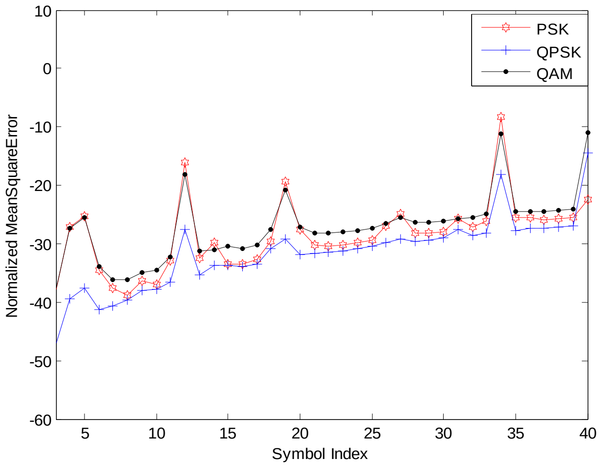


Fig.3 NMS Responses on Channel length=10 and Doppler frequency=10 Hz

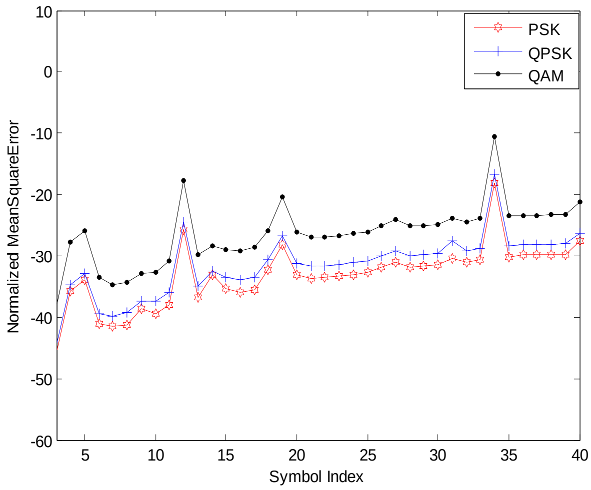


Fig.4 NMS Responses on Channel length=20 and Doppler frequency=10 Hz

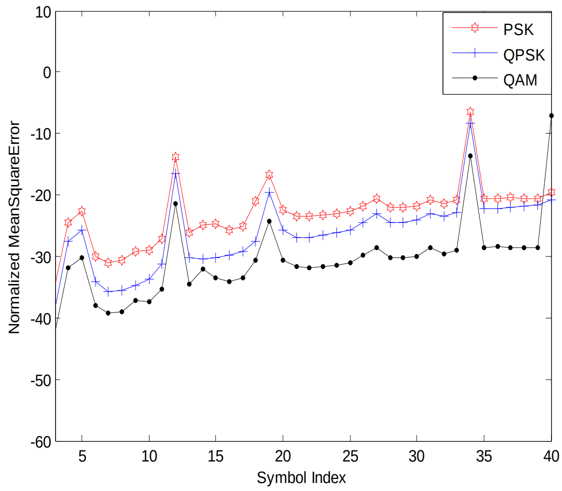


Fig.5 NMS Responses on Channel length=40 and Doppler frequency=10 Hz

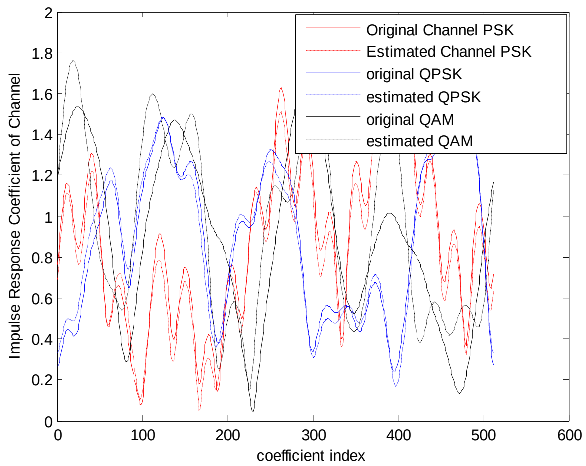


Fig.6 Channel Responses on Channel length=40 and Doppler frequency=10 Hz

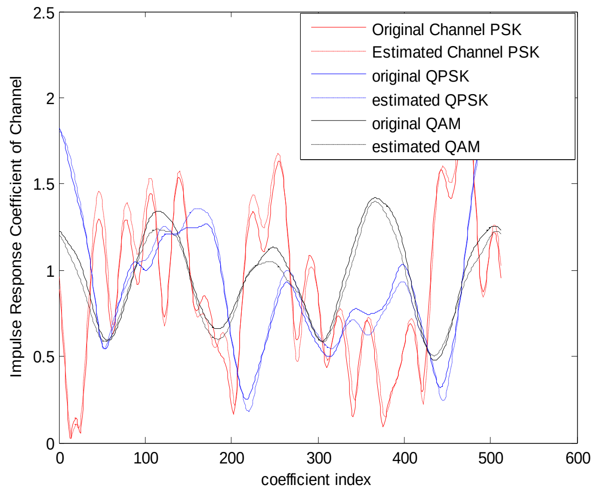


Fig.7 Channel Responses on Channel length=30 and Doppler frequency=10 Hz

IX. CONCLUSION

The channel estimation and tracking based on pilot algorithms are investigated for reuse1 OFDMA system, which is in compatible with IEEE 802.16e standard. We studied and simulated MSL method for sample spaced channels. The FFT based method is affected by the "smearing effect" due to the pulse shaping in the OFDMA symbol because of this it's performance curve reaches an error floor at high SNR. MLS method is always superior to the other. We studied the

performance of MLS method under the channel varying inside an OFDMA symbol. This introduces ICI and causes the MLS method to reach an error floor at high SNR.
I have seen the effect of varying channel length and fixed on different modulation technique assume fixed Doppler Frequency. We get that QAM is better than other modulation technique for varying Channel length and fixed Doppler Frequency. We get the impulse response of channel using PSK, QPSK, and QAM modulation techniques.

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