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ANALYSIS OF EQUALIZED OFDM IN 3G COMMUNICATION SYSTEMS

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Abstract

The goal for the third generation of mobile communications system is to integrate a wide variety of communication services such as high speed data, video and multimedia traffic as well as voice signals. In this situation the OFDM (Orthogonal Frequency Division Multiplexing) communication system is a suitable option for high band width data transmission, by converting the wideband signal into a parallel narrow band signals for parallel transmission. The transmission of these individual narrow band signals are executed with orthogonal frequency carrier. And Under the Universal Mobile Telecommunication System (UMTS) environment the Third Generation (3G) has many advantages such as highly efficient spectrum utilization and variable user data rates. In this paper, we present the bit error probability (BEP) performance analysis of Rayleigh Fading Channel with BPSK and QPSK modulation technique and the linear pilot–assisted channel estimation receiver. Each narrowband OFDM signal suffers from frequency fading and, thus, needs a one-tap equalizer to compensate for the corresponding channel distortion. The Channel estimation is usually needed to compensate for the amplitude and phase distortions associated with a received orthogonal frequency-division multiplexing (OFDM) waveform. This paper also presents a systematic approach for analyzing the bit-error probability (BEP) of equalized OFDM signals in Rayleigh fading. The data is modulated, encoded, spread and transmitted through a frequency selective Rayleigh fading channel.

The results obtained here can be applied to evaluate the performance of equalized single-carrier narrowband systems as well in the same environment.

Keywords: BEP Analysis, Flat Fading, Rayleigh Fading, Frequency Division Multiplexing, OFDM, Equalized OFDM.

Introduction

In OFDM, system contains multiple carriers i.e., because of higher band divided into number of narrow band because of which there are number of sub carrier are present in the transmitted signal and also include cyclic prefix such that it can protect against multipath channel and also prevent the ISI in case, when cyclic prefix greater than delay of number of path i.e., multipath available in channel.ISI occurs due to combining or mixing of two or more signals (interference) causes modification in the amplitude and phase of the resultant signal (received signal). To eliminate these effect, trial sub carriers are transmitted, which predict the multipath channel behavior.

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OFDM System Model

OFDM efficiently squeezes multiple modulated carriers tightly together reducing the required bandwidth but keeping the modulated signals orthogonal so that they do not interfere with each other. Various channel estimation and diversity schemes have been proposed in literature to enhance the error performance under Rayleigh fading channel. Typical baseband system of OFDM is illustrated in Fig.1 Binary input data is first encoded by a forward error correction code. Then the encoded data is mapped. After inserting pilot, the data sequence X=[X0 X1 ….XN-1]T is transformed into time domain signal by IFFT (Inverse Fast Fourier Transform). Following IFFT block, guard time, which is chosen to be larger than the expected delay spread, is inserted to prevent ISI (Inter-Symbol Interference).After parallel to serial transform, the transmitted signal will pass through the multipath fading channel. At the receiver, Y=

[Y0 Y1….YN- 1]T is obtained after serial to parallel transform, CP (Cyclic Prefix) removing and FFT.

OFDM Application

For broadcasting it is divided into two major groups SCM (single carrier modulation) and MCM (multi carrier modulation). Table1. Shows some application of OFDM in Different countries for different and many useful tasks.

Place	Application
America	ATSC
Europe	TVB
Japan	ISDB-T
China	SCM,MCM,MCM& SS

Table1. Application

Equalizers

The wireless communication have problem of multipath distortion. Table2. Shows different application of OFDM for particular task use equalizer as per need and also show the effect of equalizer.

Application	Equalizer	Effective for
SCM	Adaptive Equalizer	Mitigate multipath effect
ATSC	DFE	Eliminate multipath effect

Table2. Effect of equalizers

These "Equalizers" are complex in Implement and implementation of these equalizer is based on filter with large number of coefficients.

SCM & MCM

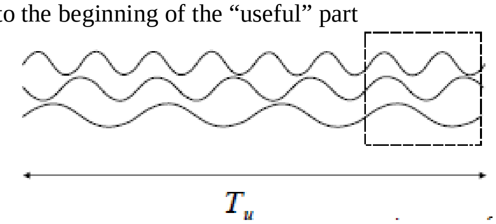
- MCM modulation protect the signal before transmission by using cyclic prefix and pilot carriers.
- SCM channel equalizer is employed to eliminate the multipath. If symbol rate is high hen symbol duration will be less.
- MCM: insteed of one by one transmission of symbol i.e., sequentially transmission MCM allow to transmit symbols in parallel mode.
- Cyclic prefix avoid overlapping between two OFDM symbols or in other words cyclic prefix avoid ISI.
- The MCM modulation can be transformed into a frequency selective channel in plane channel although the decrease of bandwidth of each sub channel. It is made increase the symbol time duration. Of course, the characteristics of signal (symbol duration) and channel (time dispersion), will say whether the channel is or not selective in frequency. The system will be developed in base band.

Consider the following characteristic:

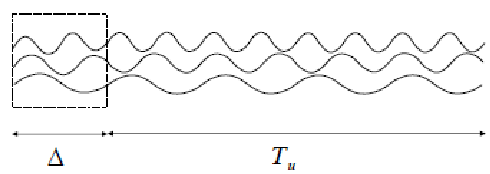
- Number of carriers: 8.
- Duration of SCM symbol: 1ms
- Data carrier constellation: QPSK.
- Data carriers: 6.
- Data carriers: 2 (first and last ones).
- Constellation for pilots carrier: BPSK.
- Guard time: 1/4.

Cyclic Prefix

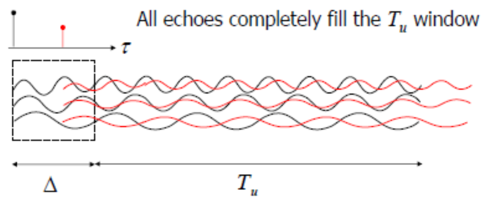
Cyclic Prefix Generation: To avoid losing the power from echoes, a copy of the end is appended to the beginning of the "useful" part



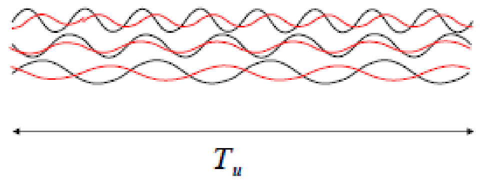
Cyclic Prefix Appended: The length of the cyclic prefix, also known as the Guard Interval, D, is supposed to be longer than the excess delay of the longest significant echo.



Effect of Multipath Delay: A delayed echo of each subcarrier adds either constructively or destructively to its un-delayed version, creating a flat-faded version of that subcarrier



CYCLIC PREFIX REMOVAL: After the symbol has been received and stored in a buffer, the cyclic prefix is removed, leaving only the modulated and faded subcarriers



Analytical Approach

The Rayleigh distribution is frequently used to model multipath fading with no direct line of sight (LOS) path. In this case, the channel fading amplitude α is distributed

Þ(α)=2α/Ω exp (-α^2/Ω), α≥0 (1)

The instantaneous signal to noise ratio power per symbol is given by γ=α2Es/No and the average SNR per symbol by

γ=ΩEs/N0, (2)

Where, ES is the energy per symbol. And hence, the instantaneous SNR per symbol of the channel γ is distributed according to an exponential distribution given by

$þ_\gamma(\gamma)=(1/\gamma)\exp(-\gamma/\bar{\gamma})$, γ≥0 (3)

Rayleigh fading is resulted from a zero-mean complex Gaussian CR process and a linear pilot-assisted channel estimate is a linear function of the true CRs at pilot symbol locations. Using our general result, we are able to derive the optimal linear channel estimate that provides the best BEP performance. This paper presents a systematic approach for evaluating the BEP performance of OFDM receivers in Rayleigh fading when a linear pilot-assisted channel estimate is used. These BEP expressions are functions of the average bit signal energy to noise level ratio (SNR), and some correlation coefficients that depend on the true channel statistic and the estimation method used.

ISI &ICI

The orthogonality of sub channels in OFDM can be maintained and individual sub channels can be completely separated at the receiver when there is no ISI and ICI introduced by transmission channel distortion. Practically these conditions cannot be governed. Since the spectra of an OFDM signal is not strictly band limited (sinc(f) function), linear distortions such as multipath causes each sub-channel to spread energy into the adjacent channels and consequently cause ICI.

A simple solution to this problem is to increase the symbol duration or the number of carriers so that the distortion becomes insignificant. However, this method may be difficult to implement in terms of carrier stability, Doppler shift, FFT size and latency.

Simulation Environment

The simulations are designed and implemented using MATLAB. Performance is evaluated by transmitting randomly generated data stream over a channel with Rayleigh fading. The stream is then received, demodulated and compared for errors with the theoretical model. MATLAB v7.4.0 (Release: 2007a) was used on HP work station which was running Microsoft Windows XP professional. The rand () function was used to create a random data stream.

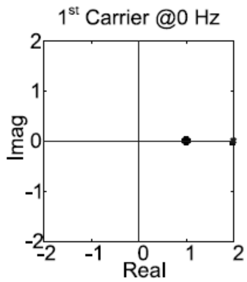
Conclusion

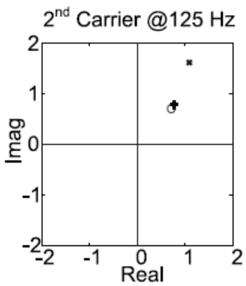
The distance between two pilots adjacent must be less than coherence bandwidth of channel. In the linear interpolation. We can see the error provoked in amplitude of response frequency. The phase is estimated without error, because the linear phase of channel contributes, then the linear interpolation can get the perfect response. Amplitude estimate is more difficult, because the curve is non-linear. In this case, it is necessary to use other interpolation method, such as, low-pass filter. After estimation of channel, the equalization can be performed using one complex gain by sub carrier. This gain adjusts the amplitude and phase of each received symbol.

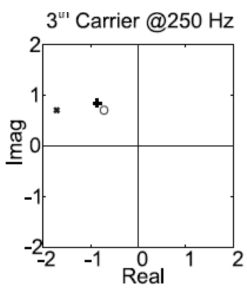
The primary advantage of OFDM over single-carrier schemes is its ability to cope with severe channel conditions. It especially well suited to handle the challenging environmental conditions experienced by mobile wireless data applications. OFDM is well positioned to meet the unique demands of mobile packet data traffic OFDM may be viewed as using many slowly-modulated narrowband signals rather than one rapidly-modulated wideband signal. Low symbol rate makes the use of a guard interval between symbols affordable, making it possible to handle time-spreading and eliminate inter-symbol interference.

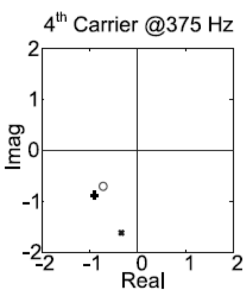
Results

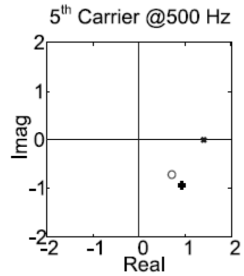
Resultant figure windows are as follows and in terms of mathematics with polar form Table 3 shows transmitted signal and received signal then last column show equalized result which show actually difference between transmitted and received.

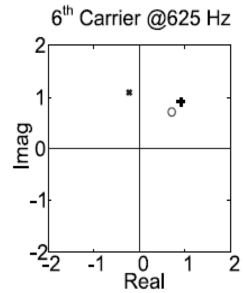


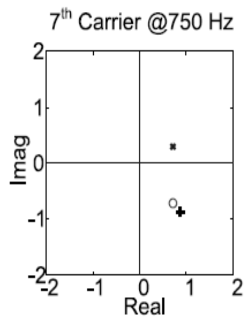


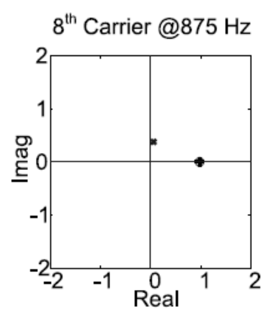












Future Enhancement

- Implementation in cognitive radio with more advancement and designing can provide improvement

- PCC-OFDM is a new method of combining coding and modulation to improve the properties of OFDM. By overlapping PCC-OFDM symbols in time, these improvements can be gained while at the same time *increasing* the overall spectral efficiency of the OFDM system.
- In term of Bandwidth consumption and power efficiency WIMAX physical layer can use instead of modulation techniques.etc…

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