Performance Analysis of Total Inter-Carrier Interference for MC-CDMA System in Mobile Environment

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Abstract
Multi-carrier code division multiple access (MC-CDMA) has been considered as a strong candidate for next generation wireless communication system due to its excellent performance in multi-path fading channel and simple receiver structure. Recent advances in wireless communications have made use of MC-CDMA and OFDM techniques to allow for high data rate transmission. Rapid time variations of the wireless communication channel have an effect on the performance of multicarrier modulation. Many ICI cancellation methods such as windowing and frequency domain coding have been proposed in the literature to cancel ICI and improve the BER performance for multi-carrier transmission technologies. Other frequency-domain coding methods do not reduce the data rate, but produce less reduction in ICI as well. In this thesis, my main objective is to evaluate the Interchannel Interference which include the Signal to Interference Ratio (SIR) and Inter Carrier Interference (ICI) in a MC DS CDMA wireless system. I find out the analytical results of interference. Simulations are given to support the system and receiver design. All the simulation is carried out on MATLAB tool.

Keywords: Doppler effect, fading channels, intercarrier interference, multicarrier code division multiple access (MC-CDMA), multicarrier modulation, orthogonal frequency division multiplexing (OFDM).

Introduction
Wireless communication is the transfer of information over a distance without the use of electrical conductors or "wires". The distances involved may be short (a few meters as in television remote control) or long (thousands or millions of kilometers for radio communications). When the context is clear, the term is often shortened to "wireless". Wireless communication is generally considered to be a branch of telecommunications. It encompasses various types of fixed, mobile, and portable two-way radios, cellular telephones, personal digital assistants (PDAs), and wireless networking. Other examples of include GPS units, garage door openers and or garage doors, wireless computer mice, keyboards and headsets, television and cordless telephones.

The demand for wireless communications services has grown tremendously. Although the deployment of 3rd generation cellular systems has been slower than was first anticipated, researchers are already investigating 4th generation (4G) systems. These systems will transmit at much higher rates than the actual 2G systems, and even 3G systems, in an ever crowded frequency spectrum. Signals in wireless communication environments are impaired by fading and multipath delay spread [23]. This leads to a degradation of the overall performance of the systems. Hence, several avenues are available to mitigate these impairments and fulfill the increasing demands.

Next-Generation Mobile Broadband Technologies
The next-generation of IMT systems based on CDMA and OFDM, as well as broadcast technologies, will be key enablers of the transition to the next dimension of wireless broadband capabilities and services. In particular, mobile broadband technologies such as CDMA2000 EV-DO Revision B (Rev. B), HSPA+, Long Term Evolution (LTE), and Mobile WiMAX (802.16m) will support multi-megabit-per-second data delivery to users, carrier-grade VoIP and other real-time and broadband intensive applications. For specific bandwidth-intensive applications such as multicasting and broadcasting, OFDM-based technologies such as DVB-H, FLO, ISDB-T, S-DMB and T-DBM have been commercialized since 2006 [30].

CDMA System
In CDMA systems, the narrowband message signal is multiplied by a very large bandwidth signal is a pseudo-noise code sequence that has a chip rate which is orders of magnitudes greater than the data rate of the message. All users in a CDMA system, use the same carrier frequency and may transmit simultaneously. Each user has its own pseudorandom codeword which is approximately orthogonal to all other code words. The receiver performs a time correlation operation to detect only the specific desired codeword. All other code words appear as noise due to decorrelation. For detection of the message signal, the receiver needs to know the codeword used by the transmitter. Each user operates independently with no knowledge of the other users.

CDMA is achieved by modulating the data signal by pseudo-random noise sequence (PN Code), which has a chip rate higher than the bit rate of the data as shown in Fig.1 The PN code sequence is a sequence of ones and zeros (called chips), which alternate in a random fashion. Modulating the data with this PN sequence generates the CDMA signal.
modulation is performed by multiplying the data (XOR operator for binary signals) with the PN sequence.

**Figure 1:** Basic CDMA Transmitter.

**MC-CDMA System**
The previous chapter presented an overview of OFDM systems, the importance of cyclic prefix and the analysis of Inter Carrier Interference in OFDM. OFDM is an effective technique to combat the frequency selectivity of the channel. Code Division Multiple Access (CDMA) has been a strong candidate to support multimedia mobile services because it has the ability to cope up with the asynchronous nature of the multimedia traffic and can provide higher capacity as opposed to the conventional access schemes such as TDMA or FDMA. By employing Rake receivers CDMA systems can coherently combine the multipath components due to the hostile frequency selective channel. The processing gain due to spreading provides robustness to the multi-user interference. The use of conventional CDMA does not seem to be realistic when the data rates go up to a hundred megabits per second due to severe ISI and the difficulty in synchronizing a fast sequence. Techniques for reducing the symbol and chip rate are essential in this case [9].

**Simulation of Gaussian Noise**
This channel is affected by Gaussian noise. It is very easy to simulate Gaussian noise in Matlab. The “randn” command was used to generate normally distributed noise as shown in the Fig.2 below [28].

![Gaussian noise](image)

**Figure 5.2:** Gaussian noise.

In the Fig.5.3, there are two zero mean Gaussian generators. The non-complex part refers to the in-phase component of the noise and complex part refers to the quadrature component. Both components are at right angle to each other, therefore both of them will be normally distributed at right angles. Gaussian noise in time domain looks like random fluctuations with amplitude depending upon the power of noise. In the following Fig.5.4, the complex Gaussian noise can be seen for 200 input samples. The input samples were taken as zeros to observe noise. If we consider the pdf of this noise, it follows Gaussian distribution. So, it can be seen that even if there is nothing transmitted the receiver might detect something which can cause errors. Modulation is used in order to handle this problem.

**Figure 5.3:** Noise simulation flow chart.

**Conclusion**
This review paper consists analyze the future generation wireless communication system. This paper go through the concept of multicarrier modulation and CDMA concept and analyse the Multicarrier CDMA system. This topic is basically focused on the MC DS CDMA system and its analysis to evaluate the Inter channel Interference which include the Signal to Interference Ratio (SIR) and Inter Carrier Interference (ICI) in a MC DS CDMA wireless system. On Complete analysis of interchannel interference conclusion can be made that when the interchannel interference is low, i.e., small filter overlap, the results obtained with the Chi-Square Approximation are valid.

**References**
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