Performance Evaluation of 4G Wireless Communication using Complex Conjugate Encoding and 1-D Digital Filter

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Abstract - Modern 4G wireless communication system is getting popular day by day and the involvement of it is now presents in all over the world covering commerce, technical, non-technical and financial sectors. This technology is almost in everybody's hand. They utilizing it fully to automate our routine tasks and connect to each other from one end of the world to another end. The excess demand of the technology needs perfection in quality of services provided and researchers keep working on it to improve it. In this paper we are working on the improvements in the performance of the 4G wireless system. To do this, we work in the existing system we have proposed the system in which the OFDM architecture is facilitate with the spatial diversity of 2 transmitter and 2 receiver antennas. To reduce the error rate due to interferences and fading effect, Complex Conjugate Coding is utilized. The proposed system has achieved the bit error rate about $8x10^{-8}$ for the 512 number of symbols which is better than the existing system.

Keywords - 4G, Wireless Communication, Complex Conjugate Encoding, BER, 1-D Digital Filter, Spatial Diversity, OFDM.

I. INTRODUCTION

The term 4G is used broadly to include several types of broadband wireless access communication systems, not only cellular telephone systems. One of the terms used to describe 4G is MAGIC—Mobile multimedia, anytime anywhere, Global mobility support, integrated wireless solution, and customized personal service. As a promise for the future, 4G systems, that is, cellular broadband wireless access systems, have been attracting much interest in the mobile communication arena. The 4G systems not only will support the next generation of mobile service, but also will support the fixed wireless networks. This paper presents an overall vision of the 4G features, framework, and integration of mobile communication. The features of 4G systems might be summarized with one word Integration. The 4G systems are about seamlessly integrating terminals, networks, and applications to satisfy increasing user demands. The continuous expansion of mobile communication and wireless networks shows evidence of exceptional growth in the areas of mobile subscriber, wireless network access, mobile services, and applications. An estimate of 1 billion users by the end of 2003 justifies the study and research for 4G systems. Numerous incompatible analog systems were placed in service around the world during the 1980s.

The 2G (second generation) systems designed in the 1980s were still used mainly for voice applications but were based on digital technology, including digital signal processing techniques. These 2G systems provided circuit-switched data communication services at a low speed. The competitive rush to design and implement digital systems led again to a variety of different and incompatible standards such as GSM (global system mobile), mainly in Europe; TDMA (time division multiple access) (IS-54/IS-136) in the U.S.; PDC (personal digital cellular) in Japan; and CDMA (code division multiple access) (IS-95), another U.S. system. These systems operate nationwide or internationally and are today's mainstream systems, although the data rate for users in these system is very limited. During the 1990s, two organizations worked to define the next, or 3G, mobile system, which would eliminate previous incompatibilities and become a truly global system.

The 3G system would have higher quality voice channels, as well as broadband data capabilities, up to 2 Mbps. Unfortunately, the two groups could not reconcile their differences, and this decade will see the introduction of two mobile standards for 3G. In addition, China is on the verge of implementing a third 3G systems. An interim step is being taken between 2G and 3G, the 2.5G. It is basically an enhancement of the two major 2G technologies to provide increased capacity on the 2G RF (radio frequency) channels and to introduce higher throughput for data service, up to 384 kbps. A very important aspect of 2.5G is that the data channels are optimized for packet data, which introduces access to the Internet from mobile devices, whether telephone, PDA (personal digital assistant), or laptop. However, the demand for higher access speed multimedia communication in today's society, which greatly depends on computer communication in digital format, seems unlimited. According to the historical indication of a generation revolution occurring once a decade, the present appears to be the right time to begin the research on a 4G mobile communication system. mobile technologies through advanced technologies. Application adaptability and being highly dynamic are the main features of 4G services of interest to users.

These features mean services can be delivered and be available to the personal preference of different users and support the users' traffic, air interfaces, radio environment, and quality of service. Connection with the network applications can be transferred into various forms and levels correctly and efficiently. The dominant methods of access to this pool of information will be the mobile telephone, PDA, and laptop to seamlessly access the voice communication, high-speed information services ,and entertainment broadcast services.

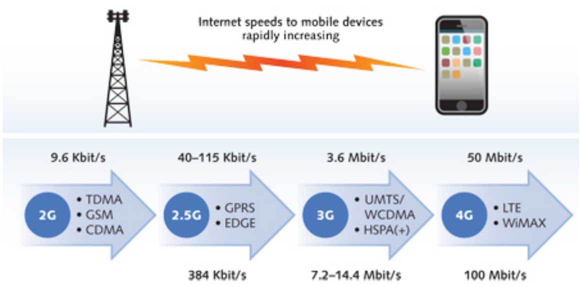
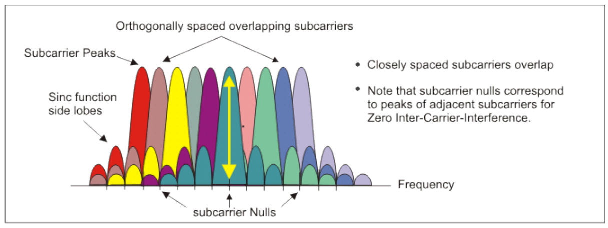


Fig 1. 4G Mobile Communication

Figure 1 illustrates elements and techniques to support the adaptability of the 4G domain. The fourth generation will encompass all systems from various networks, public to private; operator-driven broadband networks to personal areas; and ad hoc networks. The 4G systems will interoperate with 2G and 3G systems, as well as with digital (broadband) broadcasting systems. In addition, 4G systems will be fully IP-based wireless Internet. This all encompassing integrated perspective shows the broad range of systems that the fourth generation intends to integrate, from satellite broadband to high altitude platform to cellular 3G and 3G systems to WLL (wireless local loop) and FWA (fixed wireless access) to WLAN (wireless local area network) and PAN (personal area network),all with IP as the integrating mechanism. With 4G, a range of new services and models will be available. These services and models need to be further examined for their interface with the design of 4G systems.

II. SYSTEM MODEL

OFDM is robust in adverse channel conditions and allows a high level of spectral efficiency. Multiple access techniques which are quite developed for the single carrier modulations (e.g. TDMA, FDMA) had made possible of sharing one communication medium by multiple number of users simultaneously. The sharing is required to achieve high capacity by simultaneously allocating the available bandwidth to multiple users without severe degradation in the performance of the system. FDMA and TDMA are the well known multiplexing techniques used in wireless communication systems. Orthogonal Frequency Division Multiplexing (OFDM) is a special form of multi carrier modulation technique which is used to generate waveforms that are mutually orthogonal. In an OFDM scheme, a large number of orthogonal, overlapping, narrow band sub-carriers are transmitted in parallel. These carriers divide the available transmission bandwidth. The separation of the sub-carriers is such that there is a very compact spectral utilization. With OFDM, it is possible to have overlapping sub channels in the frequency domain, thus increasing the transmission rate. In order to avoid a large number of modulators and filters at the transmitter and complementary filters and demodulators at the receiver, it is desirable to be able to use modern digital signal processing techniques, such as fast Fourier transform (FFT).



OFDM Signal Frequency Spectra

Fig. 2.1 Frequency spectrum of OFDM

After more than forty years of research and development carried out in different places, OFDM is now being widely implemented in high-speed digital communications. OFDM has been accepted as standard in several wire line and wireless applications. Due to the recent advancements in digital signal processing (DSP) and very large-scale integrated circuits (VLSI) technologies, the initial obstacles of OFDM implementations do not exist anymore. In a basic communication system, the data are modulated onto a single carrier frequency. The available bandwidth is then totally occupied by each symbol. This kind of system can lead to inter-symbol-interference (ISI) in case of frequency selective channel. The basic idea of OFDM is to divide the available spectrum into several orthogonal sub channels so that each narrowband sub channels experiences almost flat fading. Many research centers in the world have specialized teams working in the optimization of OFDM systems. The attraction of OFDM is mainly because of its way of handling the multipath interference at the receiver.

Multipath phenomenon generates two effects (a) Frequency selective fading and (b) Intersymbol interference (ISI). The "flatness" perceived by a narrowband channel overcomes the frequency selective fading. On the other hand, modulating symbols at a very low rate makes the symbols much longer than channel impulse response and hence reduces the ISI. Use of suitable error correcting codes provides more robustness against frequency selective fading. The insertion of an extra guard interval between consecutive OFDM symbols can reduce the effects of ISI even more. The use of FFT technique to implement modulation and demodulation functions makes it computationally more efficient. OFDM systems have gained an increased interest during the last years. It is used in the European digital broadcast radio system, as well as in wired environment such as asymmetric digital subscriber lines (ADSL). This technique is used in digital subscriber lines (DSL) to provide high bit rate over a twisted-pair of wires.

The major advantages of OFDM are its ability to convert a frequency selective fading channel into several nearly flat fading channels and high spectral efficiency. However, one of the main disadvantages of OFDM is its sensitivity against carrier frequency offset which causes attenuation and rotation of subcarriers, and intercarrier interference (ICI) [1, 2]. The undesired ICI degrades the performance of the system.

III. PROPOSED METHODOLOGY

In this proposed model we are using complex conjugate coding with m-PSK modulation. AWGN channel is used for transmission with cyclic prefixing. Here first of all complex conjugate coding is done followed by modulation then data. After OFDM modulation it comes the filtering of the data, which provides the orthogonality to the subcarriers. IFFT will convert time domain signal to the frequency domain. After passing through the channel on the signal FFT will be performed with complex conjugate encoding and decoding process. Demodulated data is converted to binary form and decoded and filtered with 1-D digital filtering to obtain the original data transmitted. The Block Diagram in the transmitter section very firstly the data is modulated by m-PSK modulator followed by complex conjugate coding process and then Inverse Fast

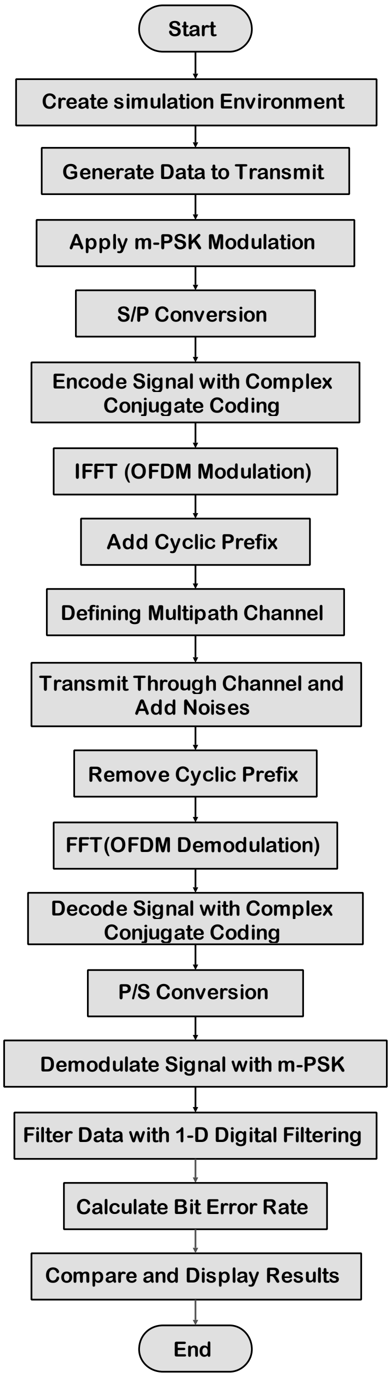


Fig. 3.1 Flow Chart of the Proposed System

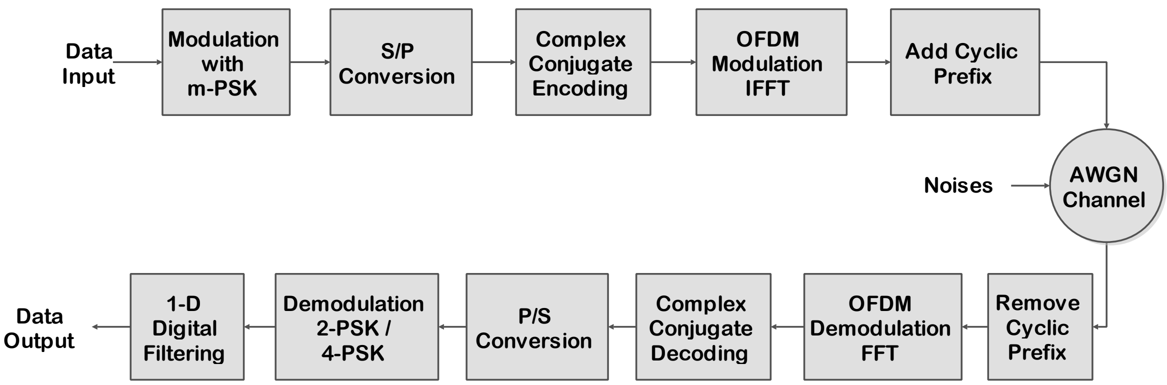


Fig. 3.2 Block Diagram of the Proposed System

Fourier Transform (IFFT) is applied for multiplexing then after addition of cyclic prefix is done with data signal through the channel the noise is mixed in the receiver section then cyclic prefix is removed Fast Fourier Transform (FFT) is applied for de-multiplexing followed by complex conjugate decoding then m-PSK demodulation has been then after 1-D digital filtering have been adopted to reduce the BER. As the above flow graph shows the whole simulation flow of proposed methodology in this firstly, the environmental variables initialized the then data is generated, m-PSK Modulates followed by complex conjugate encoding then IFFT Technique is used after that addition of cyclic prefix done then noise mixed with data signal. Then cyclic prefix is removed FFT is adopted and m-PSK demodulator is implemented with 1-D digital filter for minimizing the BER.

IV. SIMULATION OUTCOMES

The proposed system is discussed and explained in the previous section. In this section the outcomes of simulations performed on the proposed system is discussed. The system in evaluated under different data lengths and with m-PSK modulation. The results is compared for different symbol sizes with 1-D digital filter. The simulation outcomes are shown in below figures.

In Fig. 4.1 the simulation results with 256 symbols is displayed, and the performance of the proposed with m-PSK modulation and complex conjugate encoding. So here complex conjugate encoding proposed technique adopted for efficient 4G system and optimum BER achieved is $6x10^{-7}$ with 2-PSK Modulation.

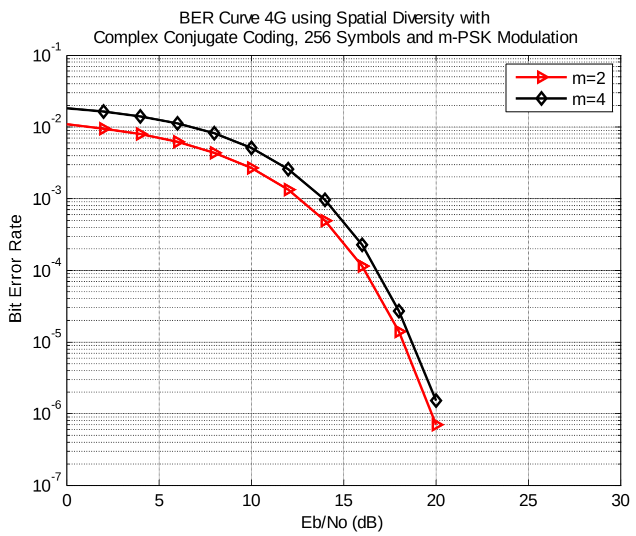


Fig. 4.1 Performance of 4G Spatial Diversity OFDM System using Complex Conjugate Encoding with 256 Symbols

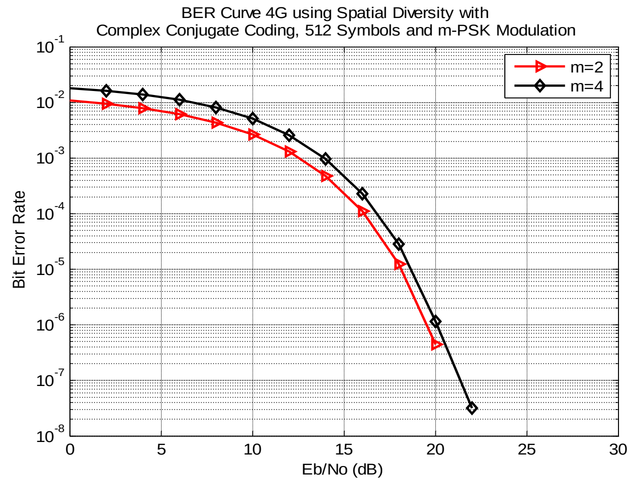


Fig. 4.2 Performance of 4G Spatial Diversity OFDM System using Complex Conjugate Encoding with 512 Symbols

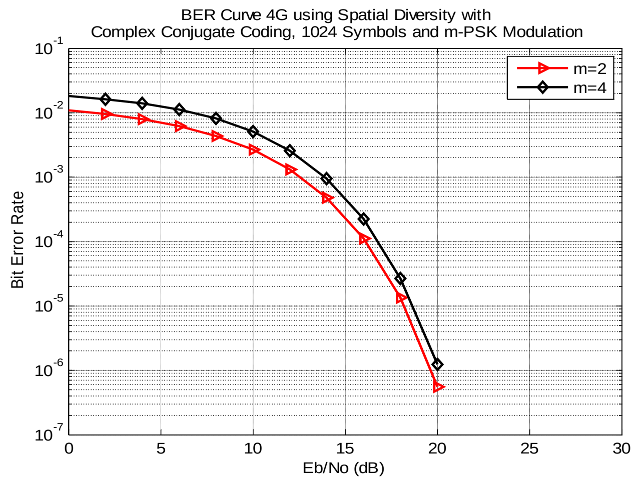


Fig. 4.3 Performance of 4G Spatial Diversity OFDM System using Complex Conjugate Encoding with 1024 Symbols

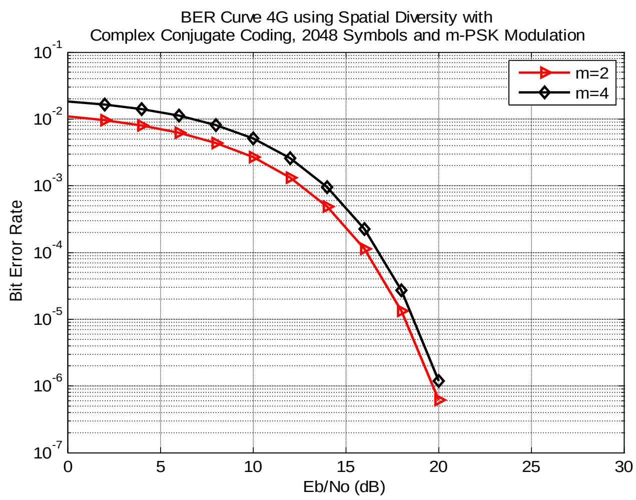


Fig. 4.4 Performance of 4G Spatial Diversity OFDM System using Complex Conjugate Encoding with 2048 Symbols

In Fig. 4.2 the simulation results with 512 symbols is displayed, and the performance of the proposed with m-PSK modulation and complex conjugate encoding. So here complex conjugate encoding proposed technique adopted for efficient 4G system and optimum BER achieved is $3x10^{-8}$ with 4-PSK Modulation. In Fig. 4.3 the simulation results with 1024 symbols is displayed, and the performance of the proposed with m-PSK modulation and complex conjugate encoding. So here complex conjugate encoding proposed technique adopted for efficient 4G system and optimum BER achieved is $1.6x10^{-7}$ with 2-PSK Modulation.

In Fig. 4.4 the simulation results with 2048 symbols is displayed, and the performance of the proposed with m-PSK modulation and complex conjugate encoding. So here complex conjugate encoding proposed technique adopted for efficient 4G system and optimum BER achieved is $8x10^{-7}$ with 2-PSK and 4-PSK Modulation.

V. CONCLUSION AND FUTURE SCOPE

The proposed 4G wireless system is simulated and the outcomes are found out in terms of BER. The BER achieved is $8x10^{-8}$ better than the existing work. The values of BER is varying with the changes in modulation techniques as well as symbols and can be say that the with 2048 symbols and m-PSK modulation scheme the wireless complex conjugate encoding based spatial diversity OFDM system outperform, the error rate is better than the previous techniques. As the symbol size increases the system also start performing better and better but more than 2048 symbols the performance is equal for 2-PSK and 4-PSK modulation. Now there are several scopes for improvements in the 4G mobile wireless communication system work towards making this system better and better with the utilization of the detection methodologies at the receiver side. The detection methods are better shield against the interferences and noises introduced during transmission.

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