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MULTICARRIER TRANSMISSION USING 4G TECHNOLOGY IN OFDM

Manish Purohit
Assistant Professor
Department of ECE
JIET
Jodhpur, India
promanish123@gmail.com

ABSTRACT: **The Orthogonal Frequency Division Multiplexing (OFDM) transmission system is one of the optimum versions of the multi-carrier transmission scheme. The OFDM is referred in the literature as Multi-carrier, Multi-tone and Fourier Transform based modulation scheme. The OFDM is a promising candidate for achieving high data rate transmission in mobile environment. In this paper, different power spectral density (PSD) curves of OFDM signal with various pulse shapes are presented. The final pulse shaped OFDM waveform is then analyzed for frequency domain response and the PSD in each case and it's also an analyzed on the basis of its modulation index which equally varies with the used window function during transmission. The simulation results are presented in a tabular manner enabling to analyze and establish the superiority, at a glance, of a specific window function applied (pulse shaped). The OFDM signals with the pulse shapes, like Rectangular, Blackman, Gaussian, Hamming and Hanning are tried. The effect of some of these time waveforms on the OFDM system performance in terms of power spectral density (PSD) & modulation index has been investigated.**

KEYWORDS- **MI, PSD, FFT, ISI, ICI, OFDM.**

I. INTRODUCTION

OFDM has been widely implemented in high speed digital communications. Due to recent advances of digital signal Processing (DSP) and Very Large Scale Integrated circuit (VLSI) technologies, the initial obstacles of OFDM implementation such as massive complex computation and high speed memory do not exist anymore .

The use of Fast Fourier Transform (FFT) algorithms eliminates arrays of sinusoidal generators and coherent demodulation required in parallel data systems and makes the implementation of the technology cost effective. The OFDM concept is based on spreading the data to be transmitted over a large number of carriers, each being modulated at a low rate. The carriers are made orthogonal to each other by appropriately choosing the frequency spacing between them. In contrast to conventional Frequency Division Multiplexing, the spectral overlapping among sub-carriers are allowed in OFDM since orthogonality will ensure the sub-carrier separation at the receiver, providing better spectral efficiency.

The orthoganality of sub channels in OFDM can be maintained and individual sub channels can be completely separated by the FFT at the receiver when there are no inter symbol interference (ISI) and inter carrier interference (ICI) introduced by the transmission channel distortion. One way to prevent ISI is to create a cyclically extended guard interval, where each OFDM symbol is preceded by a periodic extension of the signal itself. When the guard interval is longer than the channel impulse response or multi-path delay, the ISI can be eliminated.

II. OFDM TRANSMITTER

A brief description of the model is provided in Figure- 1. The incoming serial data is first converted from serial to parallel and grouped into x bits, each to form a complex number. The complex numbers are modulated in a baseband fashion by the IFFT and converted back to serial

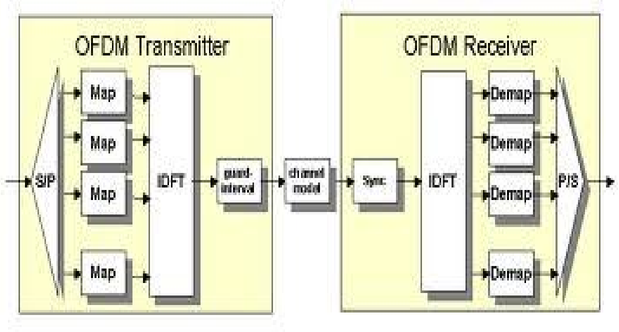

Fig.1: OFDM Transmitter & Receiver.

A guard interval is inserted between symbols to avoid inter symbol interference (ISI) caused by multi-path distortion. The discrete symbols are converted to analog and low-pass filtered for RF up-conversion.

III. 4G SYSTEM WITH IMPROVED SIGNAL QUALITY

The fourth generation of cellular communication systems, generally known as 4G and the Mobile Ad-hoc Network, generally known as MANET, have been the subject of the much research for the past several years for their unique potential to realize today's and future challenging wireless networking needs. In this paper, we investigate potential synergy from 4G and MANET specifically in the perspective of military environment for the future battlefield and also address their foreseeable limitations and challenges.

Generally known as 4G, is the emerging technology of future wireless networks. For the past years, many researchers and scientists from all over the world have been working on projects funded by governments and business institutions whose goals are efficient wireless networks by merging all current technologies and adapting new solutions for the enhanced telecommunication which provides superior quality, efficiency, and opportunities where wireless communications were not feasible.

Some researchers define 4G as a significant improvement of 3G where current cellular networks' issues will be solved and data transfer will play more significant role. For others, 4G unifies cellular and wireless local area networks and introduces new routing techniques, efficient solutions for sharing dedicated frequency band, and increases mobility and bandwidth capacity. Like 4G project, the MANET (Mobile Ad-hoc Network) is also in a developing stage. While defining the MANET standard, the Internet Engineering Task Force is working on routing techniques, like Ad-hoc On-Demand Distance Vector (AODV) and Optimized Link State Routing Protocol (OLSR) , allowing self-configuring network of mobile nodes with routing capabilities. MANET standardizes the static and mobile techniques of creating mesh networks using available wireless technology.

Currently, 802.11a/b/g/n wireless networks defined by the IEEE standards are being used at homes, offices, and also could be found in the initial MANET infrastructure. Thus, what limits cellular networks and WLANs will limit MANET as well. On the other hand, any solution that can increase capabilities of wireless networks can influence capabilities of MANET as well and furthermore could mitigate serious issues like hidden terminal problem and fading [18]. New wireless communication technologies are expected to significantly influence the design and implementation of MANETs in the military environment. Since the future technology combining wireless local networks and cellular networks is more and more being referred to, and defined as the fourth generation (4G) of communication systems, it is critical to understand the meaning of 4G and its potential in influencing wireless networks, particularly MANET.

Since we should assume low infrastructure of the mobile ad-hoc networks in the hostile military environment, 4G could be an answer to offer significant solutions for mobile MANETs to achieve high quality transmissions and constant connectivity. However, the implementation of 4G may be significantly more complicated than in the civil environment due to the unique specification and requirement of the military environment. Many Faces of 4G 4G stands for the fourth-generation cellular network. Although it is generally agreed that 4G is going to offer better communication technology than 3G, it is still undefined as to which areas should be really improved upon, and in which ways, from 3G. Researchers are often pointing towards integration whereas business institutions are working on upcoming technologies that will make 4G more attractive to the business community by implementing it more customer-friendly. This section presents different perspectives on how 4G is defined.

Later, we will investigate how the forth generation of mobile wireless networks (4GM) can be implemented in the modern military environment known as the forth generation on warfare (4GW). The role and deployment of OFDM systems will be ultimately determined by a business case, which in turn will depend on the availability of revenue-generating applications and affordable devices, the market demand for bandwidth-intensive applications and the economic benefits they offer to the operator. The industry is yet to develop a clear business model for these services, and as the experience with 3G demonstrates, it will take time for a sustainable business model to evolve.

OFDM-based solutions will be built-out over time as the demand for high-capacity broadband services grows and wider bandwidth spectrum becomes available. Meanwhile, 3G CDMA solutions will coexist with these higher-bandwidth OFDM based solutions until OFDM-based technologies are fully capable of delivering an equivalent or better value proposition to the end user, including ubiquitous coverage, compelling broadband services, carrier-grade VoIP replacing circuit-switched voice services, affordable devices, global roaming and an improved profitability for operators.

IV. NETWORKS WITH 4G

Although there are different ideas leading toward 4G, some concept and network components frequently come up as a supporting and significant solutions that help achieve progress toward 4G. In this section we are going to investigate and explain technological innovations such as MIMO (Multiple-Input Multiple-Output), OFDMA (Orthogonal Frequency Division Multiple Access) and HIP (Host Id Protocol) that could significantly increase security, mobility and throughput of 4G. OFDM-MIMO: Key to greater performance for Future Arena .

One building block for next-generation wireless access, MIMO (multiple-input, multiple-output), is an advanced antenna technology that can carry 4 to 5 times more data traffic than today's most advanced UMTS-HSDPA-ready (3G) networks. A network design incorporating MIMO technology provides the scalability needed to quickly deliver multimedia content to the mass market. With MIMO, for example, a ½ megabit picture can be downloaded in a half second or a 30-megabit video in half a minute. MIMO works by creating multiple parallel data streams between the multiple transmit and receive antennas (see figure below). Using the multi-path phenomenon, it can differentiate the separate signal paths from each MIMO antenna. Thinking back to the highway example, MIMO effectively adds several new highways.

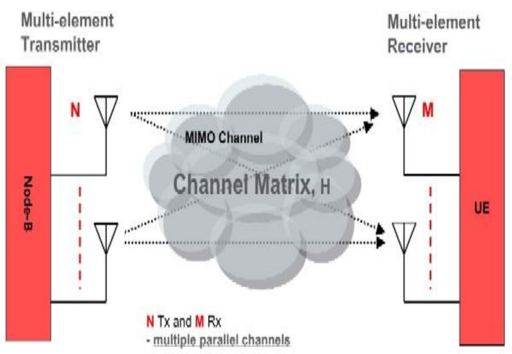

Fig.2 Multiple Path Channels In Next Generation

Another radio technology with tremendous potential for helping solve spectrum challenges is OFDM (Orthogonal Frequency Division Multiplexing). OFDM is a modulation technique, depicted in the following graphic, which uses many sub-carriers, or tones, to carry a signal.

OFDM has some key advantages over the common wireless access technology known as CDMA, which is used in many of today's 3G cellular networks. To begin with, it is more robust, which means that it provides better performance in cluttered areas with many reflections (multipath). It also allows for simpler receivers.

Perhaps most important, OFDM is more amenable to MIMO technologies. A trial conducted in Nortel's Wireless Technology Lab in early 2005 offers an example of this synergistic nature. During the trial, a mobile user had the ability to view two live streaming videos simultaneously while downloading a 264 MB file at 37 Mb/s over a standard 5MHz PCS band. Using OFDM-MIMO, the download was achieved in less than a minute compared to the 90 minutes that would be required with today's networks. This is roughly 10 times the 3.6 Mbps enabled by the first generation of HSDPA devices.

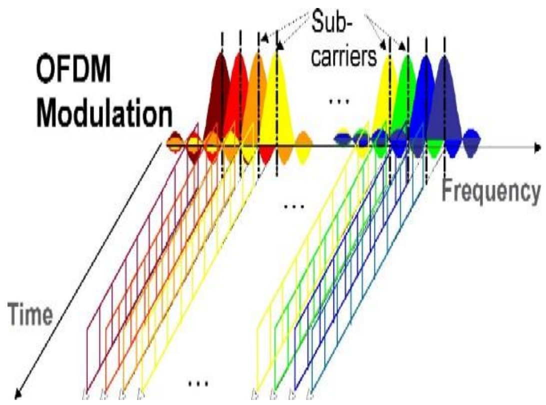

Fig. 3 - GRAPHIC Using Many Sub-Carriers

OFDM is a logical next step in broadband radio evolution. It is already being applied in IEEE standards like IEEE 802.11 and 802.16, also referred to as Wi-Fi and WiMAX, respectively. Standards groups are currently working to standardize OFDM-MIMO as it relates to Wi-Fi and WiMAX. At this time, OFDM-MIMO is not part of the formal evolution path for existing cellular systems based on the 3GPP (UMTS, HSDPA) and 3GPP2 (CDMA 1X, EV-DO) standards; however, standards groups are working to understand its role in providing wireless broadband.

V. APPLICATIONS FOR FUTURE

Orthogonal frequency-division multiplexing (OFDM) effectively mitigates Intersymbol Interference (ISI) caused by the delay spread of wireless channels. Therefore, it has been used in many wireless systems and adopted by various standards. The work presented a comprehensive survey on OFDM for wireless communications. It was addressed that basic OFDM and related modulations, as well as techniques to improve the performance of OFDM for wireless communications, including channel estimation and signal detection, time- and frequency-offset estimation and correction, peak-to-average power ratio reduction, and multiple-input–multiple-output (MIMO) techniques. It is described the applications of OFDM in current systems and standards.

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 attraction of OFDM is mainly due to how the system handles the multipath interference at the receiver. Multipath generates two effects: frequency selective fading and inter-symbol interference (ISI). The "flatness" perceived by a narrow-band channel overcomes the former, and modulating at a very low symbol rate

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