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Multiple Access Techniques For 4G Mobile Wireless Networks

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Abstract:- A number of new technologies are being integrated by the telecommunications industry as it prepares for the next generation mobile services. One of the key changes incorporated in the multiple channel access techniques is the choice of Orthogonal Frequency Division Multiple Access (OFDMA) for the air interface. This paper presents a survey of various multiple channel access schemes for 4G networks and explains the importance of these schemes for the improvement of spectral efficiencies of digital radio links. The paper also discusses about the use of Multiple Input/Multiple Output (MIMO) techniques to improve signal reception and to combat the effects of multipath fading. A comparative performance analysis of different multiple access schemes such as Time Division Multiple Access (TDMA), FDMA, Code Division Multiple Access (CDMA) & Orthogonal Frequency Division Multiple Access (OFDMA) is made vis-à-vis design parameters to highlight the advantages and limitations of these schemes. Finally simulation results of implementing some access schemes in MATLAB are provided.

I. INTRODUCTION

4G (also known as Beyond 3G), an abbreviation of Fourth-Generation, is used for describing the next complete evolution in wireless communications. A 4G system will be a complete replacement for current networks and will be able to provide a comprehensive and secure IP solution. Here, voice, data, and streamed multimedia can be given to users on an "Anytime, Anywhere" basis, and at much higher data rates than the previous generations [1], [2], [3]. 4G wireless communication standard has the following specifications:

- A spectrally efficient system (in bits/s/Hz and bits/s/Hz/site)
- High network capacity i.e., more simultaneous calls per cell
- A nominal data rate of 100 Mbit/s when the client physically moves at high speeds relative to the station, and 1 Gbit/s when client and base station are in relatively fixed positions Smooth handoff across heterogeneous networks.
- Seamless connectivity and global roaming across multiple networks.
- High quality of service for next generation multimedia support e.g. real time audio, high speed data, HDTV video content, mobile TV etc.
- Interoperability with existing wireless standards.
- An all-IP packet switched network.

  Actually the 4G system should dynamically share and utilize the network resources to meet the requirements of all the 4G enabled users. The principal design techniques to be exploited in 4G mobile wireless networks are [4], [5], [6], [7]:
- Adaptive radio interface
- Modulation, spatial processing including multi-antenna and multi-user Multiple Input/Multiple Output (MIMO) to attain ultra high spectral efficiency
- Multiple access to exploit the frequency selective channel property
- Turbo principle to minimize the required SNR at the reception side
- Relaying, including fixed relay networks (FRNs), and the cooperative relaying concept, known as multi-mode protocol

According to the 4G working groups, the infrastructure and the terminals of 4G will have almost all the standards from 2G to 4G implemented. Although legacy systems are in place to adopt existing users, the infrastructure for 4G will be only packet-based (all-IP). Some proposals suggest having an open internet platform. With the wireless standards evolution, the access techniques used also increased in efficiency, capacity and scalability. The first generation wireless standards used plain Time division Multiple Access (TDMA) and Frequency Division Multiple Access (FDMA). In the wireless channels, TDMA is less efficient in handling the high data rate channels because it requires large guard periods to alleviate the multipath impact. Again, FDMA

consumes more bandwidth for guards for avoiding inter carrier interference. So two branches came in second generation systems, one branch of standard used the combination of FDMA and TDMA and the other introduced a new access scheme called Code Division Multiple Access (CDMA) [8]. Usage of CDMA increased the system capacity. Data rate is also increased as CDMA is efficient to handle the multipath channel. This enabled the third generation systems to use CDMA as the access scheme of IS-2000, UMTS, HSXPA, 1xEV-DO, TD-CDMA and TD-SCDMA. The only issue with CDMA is that it suffers from poor spectrum flexibility and scalability. Recently, new access schemes like Orthogonal Frequency Division Multiple Access (OFDMA), Single Carrier FDMA (SC-FDMA), Interleaved FDMA (IFDMA) and Multi-carrier CDMA (MC-CDMA) are gaining more importance for the next generation systems. WiMax uses OFDMA in the downlink and in the uplink [9]. For the next generation UMTS, OFDMA is being considered for the downlink. By contrast, IFDMA is being considered for the uplink since OFDMA contributes more to the Peak-to-Average Power Ratio (PAPR) related issues and results in nonlinear operation of amplifiers. IFDMA provides less power fluctuation and thus avoids amplifier issues. Similarly, MC-CDMA is in the proposal for the IEEE 802.20 standard. The advantages of these access schemes are that they offer the same efficiencies as older technologies like CDMA, scalability and higher data rates but they require less complexity for equalization at the receiver. This is an added advantage especially in the MIMO environments as the spatial multiplexing transmission of MIMO systems requires high complexity equalization at the receiver. With these advantages in these multiplexing systems, improved modulation techniques are also used. At the present data rates of 15-30 Mbit/s, 4G is capable of providing users with streaming high-definition television. At rates of 100 Mbit/s, the content of a DVD-5 (for example a movie), can be downloaded within about 5 minutes for offline access [10]. The rest of the paper is organized as follows. Section II provides descriptions of several multiple access schemes for 4G mobile wireless networks. Section III provides a comparative performance analysis of the above schemes vis-àvis design parameters of 4G mobile wireless networks viz., throughput, Access scheme, Bit Error Rate (BER), Intersymbol Interference (ISI), equalization, Bandwidth and security issues. Simulation results of implementing CDMA and OFDMA channel access schemes in MATLAB, is provided in section IV. Section V concludes the paper with some highlights on future work.

II. MULTIPLE ACCESS SCHEMES FOR 4G MOBILE WIRELESS NETWORKS

A. FDMA

FDMA gives users an individual allocation of one or several frequency bands, or channels. It is a basic technology in the analog Advanced Mobile Phone Service (AMPS), the most widely-installed cellular phone system installed in North America. With FDMA, each channel can be assigned to only one user at a time. FDMA is also used in the Total Access Communication System (TACS). The Digital-Advanced Mobile Phone Service (D-AMPS) also uses FDMA but adds TDMA to get three channels for each FDMA channel, tripling the number of calls that can be handled on a channel. The use of frequency division multiplexing is to provide multiple and simultaneous transmissions to a single transponder. In FDMA, each transmitter is assigned a distinct frequency channel so that receivers can discriminate among them by tuning to the desired channel. TDMA and CDMA are always used in combination with FDMA, i.e., a given frequency channel may be used for either TDMA or CDMA independently of signals on other frequency channels. In 1989, the Cellular Telecommunications Industry Association (CTIA) chose TDMA over Motorola's FDMA (today known as narrowband analog mobile-phone service [NAMPS]) narrowband standard as the technology of choice for existing 800 MHz cellular markets and for emerging 1.9 GHz markets. Crosstalk is a major limitation of FDMA, which causes interference between the other frequency bands and disturbs the transmission. The features of FDMA are as follows.

• FDMA requires high-performing filters in the radio hardware, in contrast to TDMA and CDMA.
• FDMA is not vulnerable to timing problems like TDMA. Since a predetermined frequency band is available for the entire period of communication, stream data can easily be used with FDMA.
• As frequency filtering is there, FDMA is not sensitive to near-far problem which we get in CDMA.
• There is different frequency slot for every user transmission and reception happens at different frequencies.

There is a difference between FDMA and frequency-division duplexing (FDD). While FDMA allows multiple users to simultaneously access a certain system, FDD refers to how the radio channel is shared between the uplink and downlink (for instance, the traffic going back and forth between a mobilephone and a base-station). Again, Frequency Division Multiplexing (FDM) is different from FDMA. FDM is a physical layer technique that combines and transmits low bandwidth channels through a high-bandwidth channel. FDMA, on the other hand, is an access method in the data link layer [11]. Low PAPR and low sensitivity to carrier frequency offset are some of the useful properties of FDMA. A hybrid system may be formed by combining TDMA and FDMA.

B. TDMA

TDMA is a channel access method for shared medium networks. It allows several users to share the same frequency channel by dividing the signal into different time slots. The users transmit in rapid succession, one after the other, each at his time slot. This allows multiple stations to share the same transmission medium (e.g. radio frequency channel) while using only a part of its channel capacity. TDMA is used in the digital 2G cellular systems such as Global System for Mobile Communications (GSM), IS-136, Personal Digital Cellular (PDC) and iDEN, and in the Digital Enhanced Cordless Telecommunications (DECT) standard for portable phones. It is also used extensively in satellite systems, and combat-net radio systems. TDMA is a method used to enable multiple earth stations or VSAT terminals to transmit intermittently on the same frequency, but with the timing of their transmissions so arranged that the bursts do not overlay when they arrive at the satellite but arrive in sequence and thus are all successfully received by the teleport hub modem burst demodulator. The operation of TDMA requires an out link control to all the remote sites which contains some control information. This out link carrier also had a frame structure that provides accurate timing information for all the remote sites. The teleport hub equipment computer tells each VSAT site what particular time slot to use in the TDMA frame and this time plan information is broadcast to all sites periodically. The burst time plan may be fixed, so as to allocate each site a particular proportion of the total TDMA frame time or is may be dynamic, whereby the time slot allocated is adjusted in response to the traffic needs of each site [12]. Fig.1 shows the TDMA frame structure where a data stream is divided into frames and those frames divided into time slots. TDMA is a type of time-division multiplexing, with the special point that instead of having one transmitter connected to one receiver, there are multiple transmitters. In the case of the uplink from a mobile phone to a base station this becomes particularly difficult because the mobile phone can move around and vary the timing advance required to make its transmission match the gap in transmission from its peers. The features of TDMA are as follows.

• Shares single carrier frequency with multiple users
• Non-continuous transmission makes handoff simpler
• Slots can be assigned on demand in dynamic TDMA
• Less stringent power control than CDMA due to reduced intra cell interference
• Higher synchronization overhead than CDMA
• Advanced equalization may be necessary for high data rates if the channel is "frequency selective" and creates Inter symbol interference
• Cell breathing (borrowing resources from adjacent cells) is more complicated than in CDMA
• Frequency/slot allocation complexity
• Pulsating power envelop: Interference with other devices

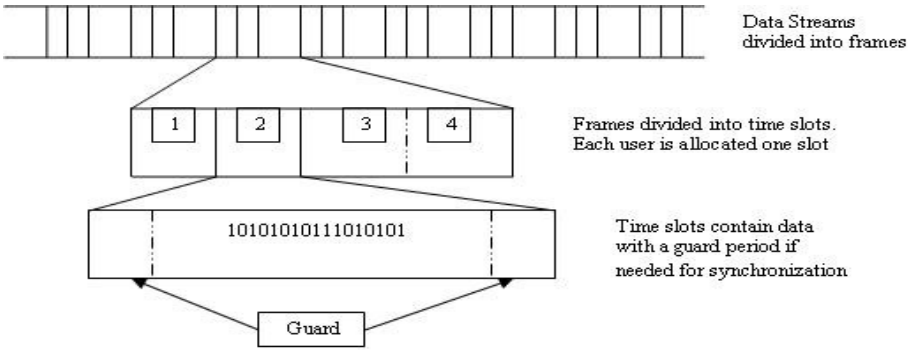


Fig. 1 TDMA Frrame Structure

TDMA can also be dynamic in nature. In dynamic TDMA, a scheduling algorithm dynamically reserves a variable number of time slots in each frame to variable bit-rate data streams, based on the traffic demand of each data stream. applications.HIPERLAN/2 broadband radio access network, IEEE 802.16a WiMax, Bluetooth, Packet Radio Multiple Access (PRMA) method for combined circuit switched voice communication and packet data, TD-SCDMA, ITU-T are some of the application areas of Dynamic TDMA.

C. CDMA

CDMA employs spread-spectrum technology and a special coding scheme (where each transmitter is assigned a code) to allow multiple users to be multiplexed over the same physical channel. By contrast, TDMA divides access by time, while FDMA divides it by frequency. CDMA is a form of "spreadspectrum" signaling, since the modulated coded signal has a much higher data bandwidth than the data being communicated. CDMA has been widely used in mobile phones and in satellite system for transportation logistics. The scheme of CDMA is briefly described below. CDMA uses the spread spectrum technique, which spreads the bandwidth of

the data uniformly for the same transmitted power. Spreading code is a pseudo-random code which has a narrow ambiguity function unlike other narrow pulse codes. In CDMA a locally generated code runs at a much higher rate than the data to be transmitted. Data for transmission is simply logically XOR (exclusive OR) added with the faster code. The figure shows how spread spectrum signal is generated. The data signal with pulse duration of Tb is XOR added with the code signal with pulse duration of Tc. (Note: bandwidth is proportional to 1 / T where T = bit time) Therefore, the bandwidth of the data signal is 1 / Tb and the bandwidth of the spread spectrum signal is 1 / Tc. Since Tc is much smaller than Tb, the bandwidth of the spread spectrum signal is much larger than the bandwidth of the original signal. The ratio Tb / Tc is called spreading factor or processing gain and determines to certain extent the upper limit of total number of users supported simultaneously by a base station. Fig. 2 shows the frame structure of CDMA. Each user in a CDMA system uses a different code to modulate their signal. Choosing the codes used to modulate the signal is very important in the performance of CDMA systems. The best performance will occur when there is good separation between the signal of a desired user and the signals of other users.

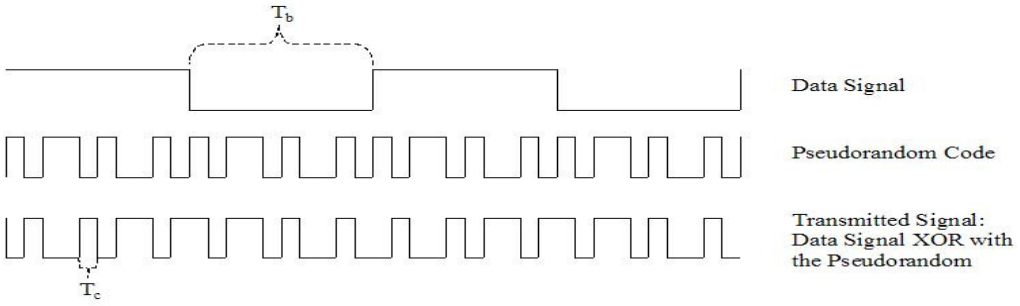
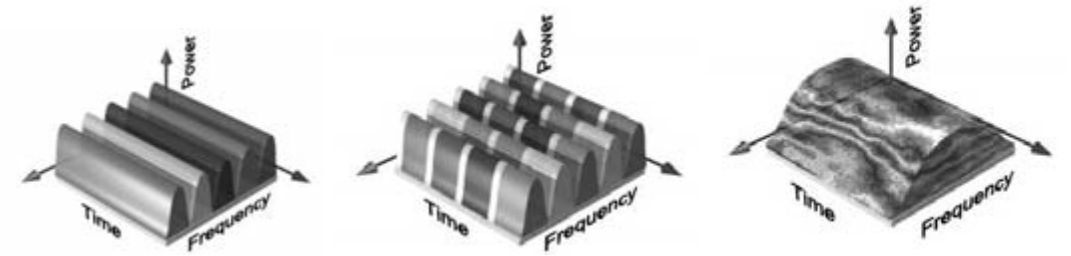


Fig. 2 CDMA Frame Structure

The separation of the signals is made by correlating the received signal with the locally generated code of the desired user. If the signal matches the desired user's code then the correlation function will be high and the system can extract that signal. If the desired user's code has nothing in common with the signal the correlation should be as close to zero as possible (thus eliminating the signal); this is referred to as cross correlation. If the code is correlated with the signal at any time offset other than zero, the correlation should be as close to zero as possible. This is referred to as auto-correlation and is used to reject multi-path interference. Flexible allocation of resources and privacy protection in due to antijamming capabilities of PN sequences are some of the advantages of CDMA. Fig.3 shows 3-D representation of FDMA, TDMA/FDMA hybrid and CDMA. FDMA shows that each narrow band channel is allocated to a single user; FDMA/TDMA hybrid shows that the bandwidth is split into frequency channels and time slots; CDMA shows that each user is allocated a different code in same frequency and time slot.



FDMA TDMA/FDMA Hybrid CDMA

Fig 3 3D Representation of Access Schemes

There are basically two types of CDMA: single carrier CDMA and multicarrier CDMA.

a) Single Carrier CDMA

Fig.4 shows the general structure of a single carrier transmission system. The transmitted symbols are pulse formed by a transmitter filter. After passing the multipath channel in the receiver a filter matched to the channel is used to maximize signal to noise ratio and the device used to extract the data. The scenario we are dealing with is Digital Video Broadcasting-Terrestrial (DVB-T), which is characterized by the following conditions [13]:

- Transmission Rate: *R =1/T = 7.4 M sym/s*

- Maximum channel delay: *τmax = 224 μs*
- ISI [14] : □*max /T* □ □*1600*

b) Multi Carrier CDMA

The complexity involved in removing the interference in the receiver of single carrier CDMA is tremendous. Using the approach in Fig.4 will only lead to sub-optimal results. This is the main reason why the multi carrier approach shown in Fig.5 has become so popular. The original data stream of rate *R* is multiplexed into *N* parallel data streams of rate *Rmc = 1/ Tmc = R/N*. Each of the data streams is modulated with a different frequency and the resulting signals are transmitted together in the same band. Correspondingly the receiver consists of *N* parallel receiver paths. Due to the prolonged distance in between transmitted symbols, the ISI for each sub system reduces to t*max* / *Tmc* = t*max* / *N*T.* In the case of DVB-T we have *N*=8192 leading to an ISI of t*max / Tmc = 0.2.* Such little ISI can often be tolerated and no extra counter measure such as an equalizer is needed. But as far as the complexity of a receiver is concerned a system with 8192 parallel paths still isn't feasible. This asks for a slight modification of the approach which leads us to the concept of OFDM.

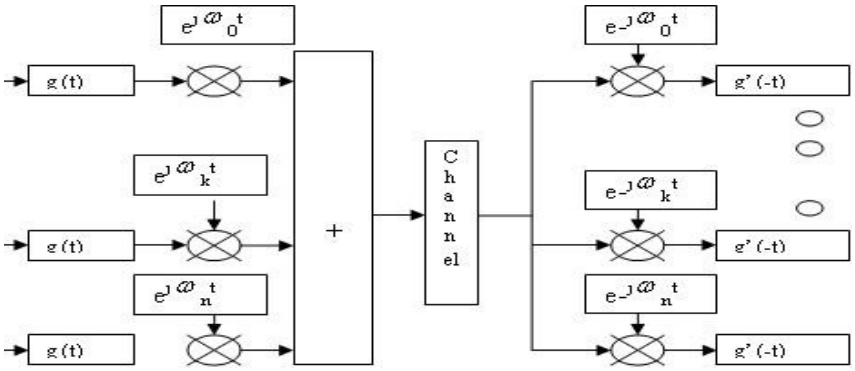


Fig. 5 Multi Carrier CDMA

D. OFDMA

OFDMA is a multi-user version of the popular OFDM digital modulation scheme. For achieving multiple accesses subsets of subcarriers are provided to the individual users in OFDMA. This allows simultaneous low data rate transmission from several users. OFDMA is also a candidate access method for the IEEE 802.22 Wireless Regional Area Networks (WRAN). The project aims at designing the first cognitive radio based standard operating in the VHF-low UHF spectrum (TV spectrum) [15]. FDMA also supports demand assignment with fixed assignment. Demand assignment allows all users apparently continuous access of the radio spectrum by assigning carrier frequencies on a temporary basis using a statistical assignment process. Single-carrier FDMA (SC-FDMA) is a kind of FDMA scheme, which is basically a multi-user version of Single-carrier Frequency-Domain-Equalization (SC-FDE) modulation scheme [16]. SC-FDE can be viewed as a linearly precoded OFDM scheme, and SC-FDMA can as a linearly precoded OFDMA scheme, henceforth LP-OFDMA. It can also be viewed as a single carrier multiple access scheme. One prominent advantage over conventional OFDM and OFDMA is that the SC-FDE and LP-OFDMA/SC-FDMA signals have lower peak-to-average power ratio (PAPR) because of its inherent single carrier structure [17].

A. Characteristics

Based on feedback information about the channel conditions, adaptive user-to-subcarrier assignment can be achieved. If the assignment is done sufficiently fast, this further improves the OFDM robustness to fast fading and narrow-band co channel interference, and makes it possible to achieve even better system spectral efficiency. Different number of sub-carriers can be assigned to different users, for supporting different Quality of Service (QoS), i.e. to control the data rate and error probability individually for each user. OFDMA resembles CDMA spread spectrum, where users can achieve different data rates by assigning a different code spreading factor or a different number of spreading codes to each user. OFDMA can be seen as an alternative to combining OFDM with TDMA or time-domain statistical multiplexing, i.e. packet Mode communication. Low-data-rate users can send continuously with low transmission power instead of using a "pulsed" high-power carrier. Constant delay, and shorter delay, can be achieved. In OFDMA, the resources are partitioned in the timefrequency space, and slots are assigned along the OFDM symbol index as well as OFDM sub-carrier index. OFDMA is considered as highly suitable for broadband wireless networks, due to advantages including scalability and MIMO friendliness, and ability to take advantage of channel frequency selectivity. In spectrum sensing cognitive radio, OFDMA is a possible approach to filling free radio frequency bands adaptively.

B. Principle of Operation

OFDM is a subset of FDM in which a single channel utilizes multiple sub-carriers on adjacent frequencies. In addition the sub-carriers in an OFDM system are overlapping to maximize spectral efficiency. Ordinarily, overlapping adjacent channels can interfere with one another. However, sub-carriers in an OFDM system are precisely orthogonal to one another. Thus, they are able to overlap without interfering. Two conditions must be considered for the orthogonality between the subcarriers [15].

1. Each subcarrier has exactly an integer number of cycles in the FFT interval.
2. The number of cycles between adjacent subcarriers differs by exactly one.

C. Orthogonality of Sub-Channel Carriers

OFDM communications systems are able to more effectively utilize the frequency spectrum through overlapping subcarriers. These sub-carriers are able to partially overlap without interfering with adjacent sub-carriers because the maximum power of each sub-carrier corresponds directly with the minimum power of each adjacent channel. OFDM channels are different from band limited FDM channels how they apply a pulse-shaping filter. With FDM systems, a sinc-shaped pulse is applied in the time domain to shape each individual symbol and prevent ISI. With OFDM systems, a sinc-shaped pulse is applied in the frequency domain of each channel. As a result, each sub-carrier remains orthogonal to one another.

D. Transmitter/Receiver

In order to use multiple sub-carriers to transmit an individual channel, an OFDM communications system must perform several steps, described in Fig.6.

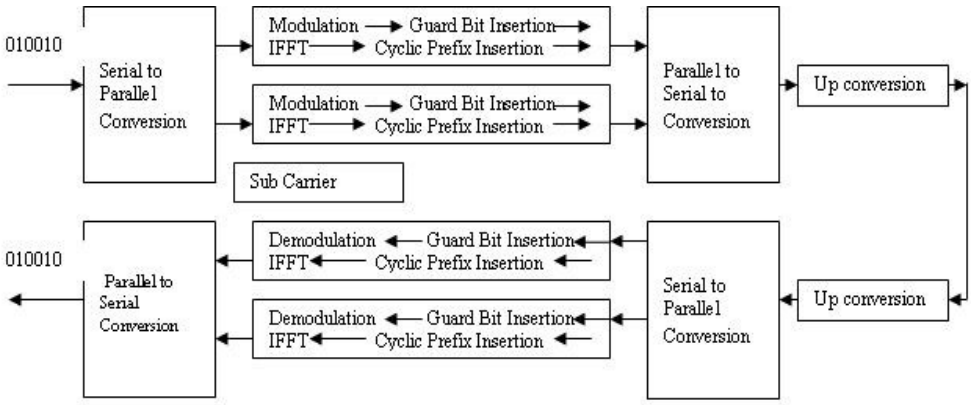


Fig. 6 OFDM Communication System

1. Serial to Parallel Conversion - In an OFDM system, each channel can be broken into various sub-carriers. The use of sub-carriers makes optimal use out of the frequency spectrum but also requires additional processing by the transmitter and receiver. This additional processing is necessary to convert a serial bit stream into several parallel bit streams to be divided among the individual carriers. Once the bit stream has been divided among the individual sub-carriers, each sub-carrier is modulated as if it was an individual channel before all channels are combined back together and transmitted as a whole. The receiver performs the reverse process to divide the incoming signal into appropriate sub-carriers and then demodulating these individually before reconstructing the original bit stream.

2. Modulation with the Inverse FFT - The modulation of data into a complex waveform occurs at the Inverse Fast Fourier Transform (IFFT) stage of the transmitter. Here, the modulation scheme can be chosen completely independently of the specific channel being used and can be chosen based on the channel requirements. In fact, it is possible for each individual sub-carrier to use a different modulation scheme. The role of the IFFT is to modulate each sub-channel onto the appropriate carrier.

3. Cyclic Prefix Insertion - Wireless communications systems are susceptible to multi-path channel reflections; a cyclic prefix is added to reduce ISI. A cyclic prefix is a repetition of the first section of a symbol that is appended to the end of the symbol. In addition, it is important because it enables multipath representations of the original signal to fade so that they do not interfere with the subsequent symbol. Fig.7 shows the block diagram of Cyclic Prefix Insertion

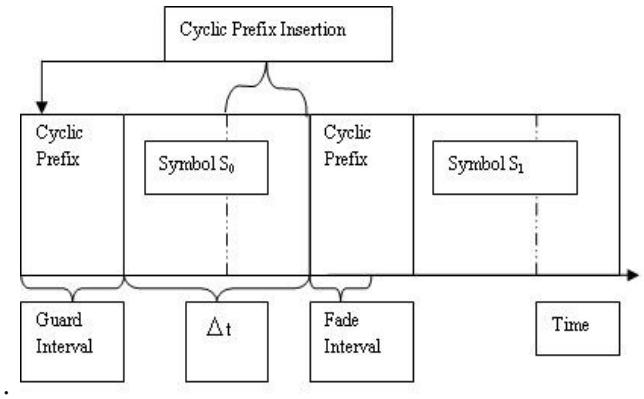


Fig. 7 Cycle Prefix Insertion

4. Parallel to Serial Conversion - Once the cyclic prefix has been added to the sub-carrier channels, they must be transmitted as one signal. Thus, the parallel to serial conversion stage is the process of summing all sub-carriers and combining them into one signal. As a result, all subcarriers are generated perfectly simultaneously. Several common commercial protocols, such as DVB, asymmetric digital subscriber line (ADSL), and wireless Ethernet (WiFI) implement OFDM. With WiFI, the IEEE 802.11a and IEEE 802.11g implementations specifically use

OFDM techniques. With IEEE 802.11g, each channel occupies 16.25 MHz of bandwidth at the 2.4GHz frequency range. In addition, each channel is divided into 52 sub-carriers of 312.5 kHz. Together, these sub-carriers overlap to fully utilize the 16.25 MHz channel bandwidth dedicated per channel. In addition, each sub-carrier can use a unique modulation scheme. More specifically, WiFI can use BPS, QPSK, 16-QAM, or 64-QAM depending on the characteristics
of the physical channel being used. One of the newest wireless internet protocols, WiMAX, also used OFDM technology.

III. PERFORMANCE ANALYSIS

Several parameters are considered here for the comparative performance analysis of the above schemes vis-à-vis design parameters of 4G mobile wireless networks.

• *Throughput*: In communication networks, throughput or network throughput is the average rate of successful message delivery over a communication channel. This data may be delivered over a physical or logical link, or pass through a certain network node.

• *Access Scheme*: In telecommunications and computer networks, a channel access method or multiple access method allows several terminals connected to the same multi-point transmission medium to transmit over it and to share its capacity. Examples of shared physical media are wireless networks, bus networks, ring networks, hub networks and half-duplex point-to-point links. A channel-access scheme is based on a multiplexing method, which allows several data streams or signals to share the same communication channel or physical medium.

• *Delay*: In a network based on packet switching, transmission delay is the amount of time required to push all of the packet's bits into the wire. In other words, this is the delay caused by the data-rate of the link. Transmission delay is a function of the packet's length and has nothing to do with the distance between the two nodes. This delay is proportional to the packet's length in bits, It is given by the following formula: $DT = N / R$ where DT is the transmission delay N is the number of bits, and R is the rate of transmission (say in bits per second)

• *Bandwidth*: Bandwidth is the difference between the upper and lower frequencies in a contiguous set of frequencies. It is typically measured in hertz, and may sometimes refer to *passband bandwidth*, sometimes to *baseband bandwidth*, depending on context.

• *Dynamic Power Management*: Dynamic power management is a design methodology aiming at controlling performance and power levels of digital circuits and systems, with the goal of extending the autonomous operation time of battery powered systems, providing graceful performance degradation when supply energy is limited, and adapting power dissipation to satisfy environmental constraints.

• *BER*: In digital transmission, the number of bit errors is the number of received bits of a data stream over a communication channel that has been altered due to noise, interference, distortion or bit synchronization errors. It is the number of bit errors divided by the total number of transferred bits during a studied time interval.

• *ISI*: In telecommunication, inter symbol interference (ISI) is a form of distortion of a signal in which one symbol interferes with subsequent symbols. This is an unwanted phenomenon as the previous symbols have similar effect as noise, thus making the communication less reliable

• *Equalization*: It is the process of adjusting the volume of certain frequencies within a signal.
• *Security*: Communications security is the discipline of preventing unauthorized interceptors from accessing telecommunications in an intelligible form, while still delivering content to the intended recipients
• *PAPR*: The peak-to-average power ratio (PAPR) is a measurement of a waveform, calculated from the peak amplitude of the waveform divided by the RMS value of the waveform. Table I gives a comparative performance analysis of FDMA, TDMA, CDMA and OFDMA with respect to these design parameters.

IV. SIMULATION RESULTS

This section provides the simulation results of implementing two different channel access schemes in MATLAB. Our simulation is restricted to OFDMA as this technology surpass the other two technologies viz., FDMA and TDMA in terms of different network parameters for 4G mobile wireless networks as seen from Table I. Fig. 8 show the frequency response characteristics of OFDMA signals as simulated in MATLAB.

Parameters	FDMA	TDMA	CDMA	OFDMA
Throughput	Low	Low	Moderate	High
Access Scheme	Uses Frequency Slots	Uses Time Slots	Uses Spread Spectrum	Uses Frequency Selective Channel
Delay	Short	Increases with Users	Substantial	Constant and Shorter
Allocated Bandwidth	12.5 MHz	12.5 MHz	12.5 MHz	12.5 MHz
Required Channel Bandwidth	.03 MHz	.03 MHz	1.25 MHz	1.25 MHz-20 MHz
Dynamic Bandwidth Allocation	No	Yes	Yes	Yes
Dynamic Power Management	No	No	Yes	Yes
BER	High	High	Lower	Lower
ISI	Low	Low	Mitigated	Absent
Calls/RF Channel	4	1	40	200

Table I Comparative Analysis

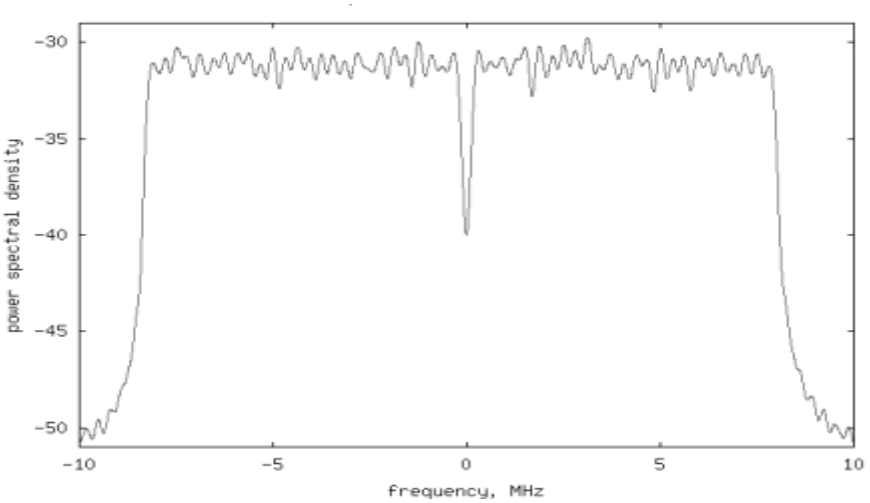


Fig 8 Frequency Response Characteristics of OFDMA Signal

V. CONCLUSION

Table I shows that OFDMA surpasses all the other schemes in terms of various parameters. So it is the right choice of multiple channel access schemes for 4G mobile wireless networks. However in spite of all the utilities of OFDMA, there are certain obstacles in using OFDM in transmission system in contrast to its advantages. Firstly OFDM signal exhibits a very high PAPR. Therefore, RF power amplifiers should be

operated in a very large linear region. Otherwise, the signal peaks get into non-linear region of the power amplifier causing signal distortion. This signal distortion introduces inter modulation among the subcarriers and out of band radiation. Thus, the power amplifiers should be operated with large power back-offs. On the other hand, this leads to very inefficient amplification and expensive transmitters. Thus, it is highly desirable to reduce the PAPR. Secondly it is very sensitive to frequency errors caused by frequency differences between the local oscillators in the transmitter and the receiver. Hence carrier frequency offset causes a number of impairments including attenuation and rotation of each of the subcarriers and ICI between subcarriers. In the mobile radio environment, the relative

Movement between transmitter and receiver causes Doppler frequency shifts; in addition, the carriers can never be perfectly synchronized. These random frequency errors in OFDM system distort orthogonality between subcarriers and thus ICI occurs. A Number of methods have been developed to reduce this sensitivity to frequency offset. Thirdly asynchronous data communication services such as web access are characterized by short communication bursts at high data rate. Few users in a base station cell are transferring data simultaneously at low constant data rate. Fourthly dealing with co-channel interference from nearby cells is more complex in OFDM than in CDMA. It would require dynamic channel allocation with advanced coordination among adjacent base stations.

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