**4G Wireless System:Technology And Applications**

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***Abstract* —The approaching 4G wireless system are projected to solve still-remaining problems of 3G systems and to provide a wide variety of new services from high-quality voice to high definition video to high-data-rate wireless channel.This paper explores 4G wireless system, its features technologies and applications to fulfill its requirement.**

***Keywords–*4G wireless system,Techonologies-OFDM,UWB, Milimeter Wireless, Smart Antennas, Long Term Power Pridiction,Scheduling among users ,Adaptive Modulation & Power Control**

**I. INTRODUCTION**

4 Generation of wireless is intended to complement and replace the 3G systems. Accessing information anywhere, anytime, with a seamless connection to a wide range of information and services, and receiving a large volume of information,data, pictures, video.4G Wireless defined by ITU (International Telecommunication Union).Fourth generation wireless system is a packet switched wireless system with wide area coverage and high throughput. It is designed to be cost effective and to provide high spectral efficiency .The 4g wireless uses such techniques Orthogonal Frequency Division Multiplexing (OFDM), Ultra Wide Radio Band (UWB),Milimeter Wireless, Smart Antennas, Long Term Power Pridiction,Scheduling among users,Adaptive Modulation & Power Control.

In this paper, section I talk about the 4G Wireless System ,application and which techonologies are used in their.

Section II gives the Features of 4G Wireless system.

Section III provides the brief description of technologies such asOFDM,UWB,Milimeter Wireless, Smart Antennas, Long Term Power Pridiction, Scheduling among users,Adaptive Modulation & Power Control.

Section IV explains the Applications and Services.

**II. Features of 4G Wireless System**

There are several features in 4G are as follows:-

*A.High performance:*

4G will feature extremely high quality video of quality comparable to HD(high definition) TV. Wireless downloads at speeds reaching 100 Mbps, i.e. 50 times of 3G, are possible with 4G.

*B.Interoperability and easy roaming*

4G provides a global standard that provides global mobility. Various heterogeneous wireless access networks typically differ in terms of coverage data rate, latency, and loss rate.Therefore, each of them is practically designed to support a different set of specific services and devices, 4G will encompass various types of terminals, which may have to provide common services independently of their capabilities.This concept is referred to as service personalization.

*C.Fully converged services*

If a user want to be able to access the network from lots of different platforms: cell phones, laptops, PDAs he is freeto do so in 4G delivers connectivity intelligent and which flexible enough to support streaming video,VoIPtelephony,still or moving images, e-mail, Web browsing,e-commerce,andlocation-basedservices through a wide variety of devices. That means Freedom for consumers.

*D.Low cost*

4G systems will prove far cheaper than 3G, since they can be built atop existing networks and won't require operators to completely retool and won't require carriers to purchase costly extra spectrum. In addition to being a lot more cost efficient, 4G is spectrally efficient, so carriers cando more with less.

*E. Devices: more user friendly interface*

4G devices are expected to be more visual and intuitive rather than today’s text and menu based systems. They will be able to interact with the environment around it and act accordingly.

*F.Scalability*

It is most challenging aspect of the mobile networks. It refers to ability to handle ever increasing number of users and services. Since an all IP core layer of 4G is easily scalable, it is ideally suited to meet this challenge.

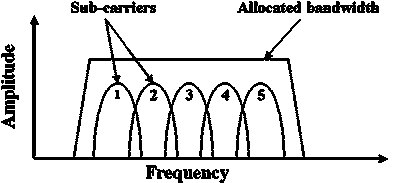
**III. Wireless Technologies used**

**in 4G**

The 4g wireless uses such techniques Orthogonal Frequency Division Multiplexing (OFDM), Ultra Wide Radio Band (UWB), Milimeter Wireless, Smart Antennas, Long Term Power Pridiction,Scheduling among users,Adaptive Modulation & Power Control.

A*. Orthogonal Frequency Division Multiplexing*

OFDM, a form ofmulti- carrier modulation, works by dividing the data stream for transmission at a bandwidth B into N multiple and parallel bit streams, spaced B/N apart (**Figure**). Each of the parallel bit streams has a much lower bit rate than the original bit stream, but their summation can provide very high data rates. N orthogonal sub-carriers modulate the parallel bit streams, which are then summed prior to transmission.



An OFDM transmitter accepts data from an IP network, converting and encoding the data prior to modulation. An IFFT (inverse fast Fourier transform) transforms the OFDM signal into an IF analog signal, which is sent to the RF transceiver. The receiver circuit reconstructs the data by reversing this process. With orthogonal sub-carriers, the receiver can separate and process each sub-carrier without interference from other sub-carriers. More impervious to fading and multi-path delays than other wireless transmission techniques, ODFM provides better link and communication quality.

B. *Ultra Wide Band*

A UWB transmitter spreads its signal over a wide portion of the RF spectrum, generally 1 GHz wide or more, above 3.1GHz. The FCC has chosen UWB frequencies to minimize interference to other commonly used equipment, such as televisions and radios. This frequency range also puts UWB equipment above the 2.4 GHz range of microwave ovens and modern cordless phones, but below 802.11a wireless Ethernet, which operates at 5 GHz.

UWB equipment transmits very narrow RF pulses—low power and short pulse period means the signal, although of wide bandwidth, falls below the threshold detection of most RF receivers. Traditional RF equipment uses an RF carrier to transmit a modulated signal in the frequency domain, moving the signal from a base band to the carrier frequency the transmitter uses.

UWB is "carrier-free", since the technology works by modulating a pulse, on the order of tens of microwatts, resulting in a waveform occupying a very wide frequency domain. The wide bandwidth of a UWB signal is a two-edged sword. The signal is relatively secure against interference and has the potential for very high-rate wireless broadband access and speed. On the other hand, the signal also has the potential to interfere with other wireless transmissions. In addition, the low-power constraints placed on UWB by the FCC, due to its potential interference with other RF signals, significantly limits the range of UWB equipment (but still makes it a viable LAN technology).

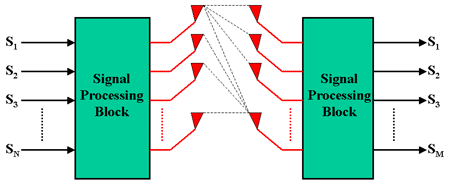
C. *Millimeter Wireless*

Using the millimeter-wave band (above 20 GHz) for wireless service is particularly interesting, due to the availability in this region of bandwidth resources committed by the governments of some countries to unlicensed cellular and other wireless applications. If deployed in a 4G system, millimeter wireless would constitute only one of several frequency bands, with the 5 GHz band most likely dominant.

D*. Smart Antenna*

A smart antenna system comprises multiple antenna elements with signal processing to automatically optimize the antennas' radiation (transmitter) and/or reception (receiver) patterns in response to the signal environment. One smart-antenna variation in particular, MIMO, shows promise in 4G systems, particularly since the antenna systems at both transmitter and receiver are usually a limiting factor when attempting to support increased data rates.

MIMO (Multi-Input Multi-Output) is a smart antenna system where 'smartness' is considered at both transmitter and the receiver. MIMO represents space-division multiplexing (SDM)—information signals are multiplexed on spatially separated N multiple antennas and received on M antennas. **Figure**shows a general block diagram of a MIMO system. Some systems may not employ the signal-processing block on the transmitter side.



Multiple antennas at both the transmitter and the receiver provideessentially multiple parallel channels that operate simultaneously on the same frequency band and at the same time. This results in high spectral efficiencies in a rich scattering environment (high multi-path), since you can transmit multiple data streams or signals over the channel simultaneously. Field experiments by several organizations have shown that a MIMO system, combined with adaptive coding and modulation, interference cancellation, and beam-forming technologies, can boost useful channel capacity by at least an order of magnitude.

*E. Long Term Power Prediction*

Channels to differentmobile users will fade independently. If the channel properties of all users in a cell can be predicted a number of milliseconds ahead, then it would be possible to distribute the transmission load among the users in an optimal way while fulfilling certain specified constraints on throughput and delays. The channel time-frequency pattern will depend on the scattering environment and on the velocity of the moving terminal.

In order to take the advantage the channel variability, we use OFDM system with spacing between subcarrires such that no interchannel interface occurs for the worst case channel scenario

(Low coherence bandwidth).A time-frequency grid constituting of regions of one time slot and several subcarriers is used such that the channel is fairly constant over each region. These time-frequency regions are then allocated tothe different users by a scheduling algorithm according to some criterion.

E. *Scheduling among Users*

To optimize the system throughput, under specified QoS requirements and delay constraints, scheduling will be used on different levels:

1.Among sectors**:-**In order to cope with co-channel interference among neighboring sectors in adjacent cells, time slots are allocated according to the traffic load in each sector .Information on the traffic load is exchanged infrequently via an inquiry procedure. In this way the interference can be minimized and higher capacity be obtained.

After an inquiry to adjacent cells, the involved base stations determine the allocation of slots to be used by each base station in each sector. The inquiry process can also include synchronization information to align the transmission of packets at different base stations to further enhance performance.

2.Among users**:-**Based on the time slot allocation obtained from inquiry process, the user scheduler will distribute time-frequency regions among the users of each sector based on their current channel predictions. Here different degrees of sophistication can be used to achieve different transmission goals.

*F.Adaptive Modulation and power*

In a fading environment and for a highly loaded system there will almost exist users with good channel conditions. Regardless of the choice of criterion, which could be either maximization of system throughput orequalization to user satisfaction, the modulation format for the scheduled user is selected according to the predicted signal to noise and interference ratio. By using sufficiently small time-frequency bins the channel can be made approximately constant within bins. We can thus use a flat fading AWGN channel assumption. Furthermore since we have already determined the time slot allocation, via the inquiry process among adjacent cells described above we may use an aggressive power control scheme, while keeping the interference on an acceptable level.

For every timeslot, the time-frequency bins in the grid represent separate channels. For such channels the optimum rate and power allocation for maximizing the throughput can be calculated under a total average power constraint. The optimum strategy is to let one user, the one with best channel, transmit in each of the parallel channels.

**IV.Applications and Services**

For purposes of this article, services are defined as functions offered to subscribers by providers. Applications are defined as programs, software, or features that take advantage of (apply) the services offered by the networks. Generally, four categories of services or applications are being developed for use in the next generations of wireless communications. They are Localized/Personalized Information, Communication,Organizationa& Entertainment.

Although localized/personalized information services and applications are geared to most users across all the user segments previously mentioned, these services are more critical to the Internet Usage, Income Brackets, and Mobile Professional segments. Localized/ personalized information services and applications will provide users with general news, financial news, location guides, mobile commerce, and travel services. These services will allow the user to establish a single profile that will be associated with the user whether in his/her home coverage area or roaming on other systems.

Communications services and applications involve messaging and other means of staying connected. These services and applications are important to all the user segments, especially the Mobile Professional segment. Communications services include short messaging service (SMS), e-mail, video conferencing, fax, and bulletin boards. Although some of these services are available in today’s wireless systems, in future generations these services will be greatly enhanced. (Speed and reliability are the most notable enhancements planned for these services.) Organizational services include personal digital assistant (PDA) capabilities, currency exchange based on user location, and other personal management applications (e.g., calendars, call management, and address books). Organizational services and applications are relevant to all the user segments but are geared primarily to the Income Brackets and Mobile Professional user segments.

Entertainment services are viewed by service providers as having the greatest potential for immediate return on investment. Entertainment services may include streaming audio, streaming video, chat, photo trading, and gaming. In the Asian wireless market, where preliminary iterations of 3G are being deployed, entertainment services are generating substantial revenue. The user segment targeted for entertainment services is the Age segment.

Another service generating much excitement in the industry is mobile commerce (M-Commerce). M-commerce is the ability for subscribers to purchase items (e.g., gas, food from vending machines, etc.) using a wireless device. For example, to purchase an item from a vending machine, users would dial a phone number or access code associated with the item (most likely marked on the vending machine) and the item would be dispensed. In this scheme, the vending machine would be connected to the public switched telephone network (PSTN) via a modem or other gateway-type device. The wireless service provider would pass the information to the vending company and the vending company would, in turn, pass the information to the vending machine to instruct it to dispense the item. The user's wireless service account would be billed for any items purchased, much like a credit card. This type of M-commerce is currently being tested and implemented (on a very limited basis) in select countries in Europe and Asia already having advanced, 2.5G wireless networks. M-commerce can be considered an Information and/or an Organization type of service.

**V.Conclusion**

4G offers us to provide with a very efficient and reliable wireless communication system for seamless roaming over various network including internet which uses IP network. The 4G system will be implemented in the coming years which are a miracle in the field of communication engineering technology.

This paper provided an overview of the 4G evolution and technologies. 4G will certainly add perceived benefit to anordinary person’s life over 3G. 4G will be an intelligenttechnology that will interconnect the entire world seamlessly.

Projected 4G mobile communication system will reducenumber of different technologies to a single global standard.Technologies are evolving every day and night but the finalsuccess of 4G mobile communication will depend upon thenew services and contents made available to users.Thesenew applications must meet user expectations, and giveadded value over existing offers.

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