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5G Technology of Mobile Communication

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***ABSTRACT-* The modern world is shrinking due to the development of science and its technology. Over the years, wireless telecommunication market has long been recognized as one of the most dynamic and fastest growing segments of the global telecommunication industry. But requirement of human being augment day by day. However further modernization will be on convergence of the existing technology in to a single platform. Mobile broadband is becoming a reality, as the internet generation grows accustomed to having broadband access wherever they go and not just at home or in the office. This paper mainly focuses on how a 5G network can provide more approach to a common man to utilize his available possessions in an immense way to make him to feel the real progress.**

Keywords- 5G, wireless, telecommunication, networks .

1.0 Introduction

First generation wireless mobile communication system is not digital technology, but analog cellular telephone system which was used for voice service only during the early 1980s. This Advanced Mobile Phone System (AMPS) was a frequency modulated analog mobile radio system using Frequency Division Multiple Access (FDMA) with 30kHz channels occupying the 824MHz − 894MHz frequency band and a first commercial cellular system deployed until the early 1990's.[1]

The second generation (2G) wireless mobile systems are digital cellular systems. Comparing with the first generation, the second generation wireless system used digital modulation scheme, such as time division multiple access (TDMA) and code division multiple access (CDMA). Based on the two techniques, there were three primary 2G mobile communication systems. They are TDMA (IS-136), CDMA (IS-95), and GSM. TDMA (IS-136), as a completely digital system, was deployed in North America in 1993, but operated in the AMPS frequency band of 824MHz-894MHz. CDMA (IS-95) systems using Direct Sequence Spread Spectrum (DSSS) are working on the 1850-1990 MHz frequency band to support CDMA carriers.[1]

Third generation: An attempt to establish an international standard for 3G mobile is being moderated through the ITU, under the auspices of its IMT-2000 program. It was inveterate in late 2000.It provides transmission speed up to 2Mbps. Third generation (3G) services combine high speed mobile access with Internet Protocol (IP)-based services. Apart from transmission speed innovative enhancement was made in Quality of services. Add on services such as global roaming, better voice quality, always on made 3G as a significant generation.[2]

4G is an abbreviation for Fourth-Generation, is a term used to describe the next complete evolution in wireless communications**.** The approaching 4G (fourth generation) mobile communication systems are projected to solve still remaining problems of 3G (third generation) systems and to provide a wide variety of new services, from high-quality voice to high-definition video to high data-rate wireless channels. 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.[2]

1.1 5G: While considering a smooth migration for 5G it is apparent that it should be valid for all sorts of radio access technologies. So that it could make better revenue for current global operators as well as interoperability will become more feasible. To make 5G practical for all sorts of radio access technologies there should be a common platform unique for

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all the technologies. One of those unique platforms is Flat IP network. Certainly Flat IP network is the key concept to make 5G acceptable for all kind of technologies. To meet customer demand for real-time data applications delivered over mobile broadband networks, wireless operators are turning to flat IP network architectures. Flat IP architecture provides a way to identify devices using symbolic names, unlike the hierarchical architecture such as that used in "normal" IP addresses.[2]

1.3 5G ARCHITECTURE

Fig. 1.1 5G mobile phone design [3]

Fig.1 shows 5G mobile phone design. 5G is being developed to accommodate the QoS and rate requirements set by forthcoming applications like wireless broadband access, Multimedia Messaging Service (MMS), video chat, mobile TV, HDTV content, Digital Video Broadcasting (DVB),[3] minimal services like voice and data, and other services that utilize bandwidth. The definition of 5G is to provide adequate RF coverage, more bits/Hz and to interconnect all wireless heterogeneous networks to provide seamless, consistent telecom experience to the user. [3]

1.4 Evolved Packet Core (EPC)

Evolved Packet Core is the IP-based core network defined by 3GPP (Telecom standard) for use with LTE and other access technologies. The goal of the EPC is to provide simplified all IP core network architectures to efficiently give access to various services such as the ones provided by IMS (IP Multimedia Subsystem). EPC consists essentially of a Mobility Management Entity (MME) & access agnostic gateway foe routing of user datagram. EPC will be a completely new architecture for wireless operators, one that emulates the IP world of data Communication rather than the voice- centric world of wireless. EPC is based on flat IP network theory. Fig. 2 shows flat IP Architecture.[3]

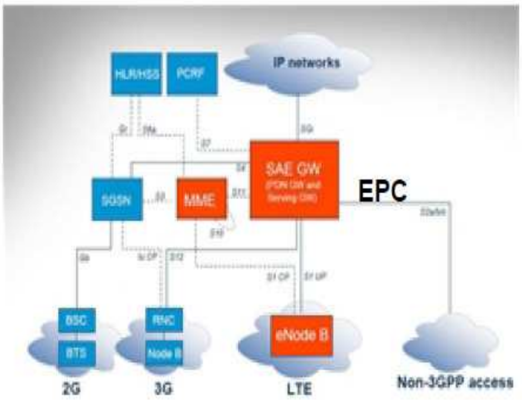

Fig 1.2 Flat IP Architecture [3]

1.5 CONCEPT OF 5G TECHNOLOGY

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Table 1. OSI Layers in the 5G Mobile Terminal Design [3]

<table>
<tr><td>Application Layer</td><td rowspan="2">Application
(Services)</td></tr>
<tr><td>Presentation Layer</td></tr>
<tr><td>Session layer</td><td rowspan="2">Open Transport Protocol</td></tr>
<tr><td>Transport Layer</td></tr>
<tr><td rowspan="2">Network layer</td><td>Upper network layer</td></tr>
<tr><td>Lower network Layer</td></tr>
<tr><td>Datalink Layer</td><td rowspan="2">Open Wireless Architecture</td></tr>
<tr><td>Physical Layer</td></tr>
</table>

Physical/MAC layers

Physical and Medium Access Control layers i.e. OSI layer 1 and OSI layer 2, define the wireless technology and shown in table.1. For these two layers the 5G mobile networks is likely to be based on Open Wireless Architecture [3].

Network layer

The network layer will be IP (Internet Protocol), because there is no competition today on this level. The IPv4 (version 4) is worldwide spread and it has several problems such as limited address space and has no real possibility for QoS support per flow. These issues are solved in IPv6, but traded with significantly bigger packet header. Then, mobility still remains a problem. There is Mobile IP standard on one side as well as many micro-mobility solutions (e.g., Cellular IP, HAWAII etc.). All mobile networks will use Mobile IP in 5G, and each mobile terminal will be FA (Foreign Agent), keeping the CoA (Care of Address) mapping between its fixed IPv6 address and CoA address for the current wireless network. However, a mobile can be attached to several mobile or wireless networks at the same time.[3] In such case, it will maintain different IP addresses for each of the radio interfaces, While each of these IP addresses will be CoA address for the FA placed in the mobile Phone. The fixed IPv6 will be implemented in the mobile phone by 5G phone manufactures. The 5G mobile phone shall maintain virtual multi-wireless network environment. For this purpose there should be separation of network layer into two sub-layers in 5G mobiles (Fig 1) i.e.: Lower network layer (for each interface) and Upper network layer (for the mobile terminal). This is due to the initial design of the Internet, where all the routing is based on IP addresses which should be different in each IP network world wide. The middleware between the Upper and Lower network layers (table 1) shall maintain address translation from Upper network address (IPv6) to different Lower network IP addresses (IPv4 or IPv6), and vice versa. Fig1.3 shows the 5G network layer.[3]

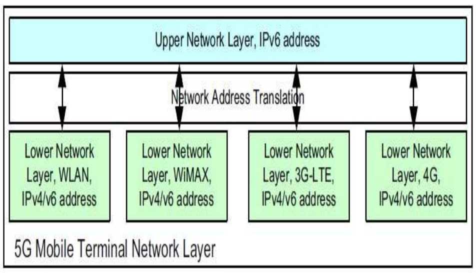

Figure 1.3 5G Mobile Terminal Network Layer [3].

Open Transport Protocol (OTA) layer

The mobile and wireless networks differ from wired networks regarding the transport layer. In all TCP versions the assumption is that lost segments are due to network congestion, while in wireless network losses may occur due to higher bit error ratio in the radio interface. Therefore, TCP modifications and adaptation are proposed for the mobile and wireless networks, which retransmit the lost or damaged TCP segments over the wireless link only. For 5G mobile terminals will be suitable to have transport layer that is possible to be downloaded and installed. Such mobiles shall have the possibility to download (e.g., TCP, RTP etc. Or new transport protocol) version which is targeted to a specific wireless technology installed at the base stations. This is called here Open Transport Protocol - OTP. [3]

Application layer

Regarding the applications, the ultimate request from the 5G mobile terminal is to provide intelligent QoS management over a variety of networks. Today, in mobile phones the users manually select the wireless interface for particular Internet service without having the possibility to use QoS history to select the best wireless connection for a given service. The 5G phone shall provide a possibility for service quality testing and storage of measurement information in information databases in the mobile terminal. The QoS parameters, such as delay, jitter, losses, bandwidth, reliability, will be stored in a database in the 5G mobile phone with the aim to be used by intelligent algorithms running in the mobile terminal as system processes, which at the end shall provide the best wireless connection upon required QoS and personal cost constraints. 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.[3] The process of IPv4 address exhaustion is expected to be in its final stages by the time that 4G is deployed. Therefore, IPv6 support for 4G is essential in order to support a large no. of wireless- enabled devices. IPv6 removes the need for NAT (Network Address Translation) by increasing the no. of IP addresses.[3] With the available address space and number of addressing bits in IPv6, many innovative coding schemes can be developed for 4g devices and applications that could help in the deployment of 4G network and services.[3] The fourth generation promises to fulfill the goal of PCC (personal computing and communication) —a vision that affordably provides high data rates everywhere over a wireless network [3].

1.6 Design of 5G Mobile Network Architecture

Figure 1.4 shows the system model that proposes design of network architecture for 5G mobile systems, which is all-IP based model for wireless and mobile networks interoperability. The system consists of a user terminal (which has a crucial role in the new architecture) and a number of independent, autonomous radio access technologies. Within each of the terminals, each of the radio access technologies is seen as the IP link to the outside Internet world. However, there should be different radio interface for each Radio Access Technology (RAT) in the mobile terminal. For an example, if we want to have access to four different RATs, we need to have four different access-specific interfaces in the mobile terminal, and to have all of them active at the same time, with aim to have this architecture to be functional.[4]

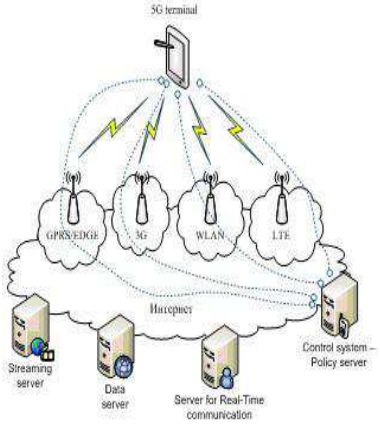

Figure 1.4 Functional architecture for 5G mobile networks [4]

Work Done

2.1 OFDM SYSTEM DESIGN An OFDM transceiver system is shown in Fig. 2.1.

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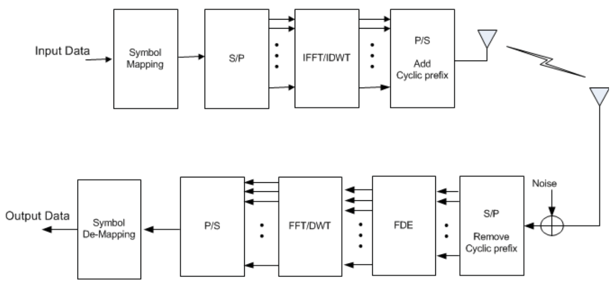

Figure 2.1: Block diagrm of the conventional OFDM system.

A Qudrature-Phase Shift Keying (QPSK) modulator is used in this work to map the binary data to appropriate QPSK symbols. The transmitted high-speed data symbol is converted into parallel data of *N* sub-channels.

2.2 PROPOSED SYSTEM MODEL

The block diagram of the proposed (FFT/DWT)-OFDM with chaotic interleaving is shown in Fig. 2.2. The previous block is modified by adding an interleaving stage.

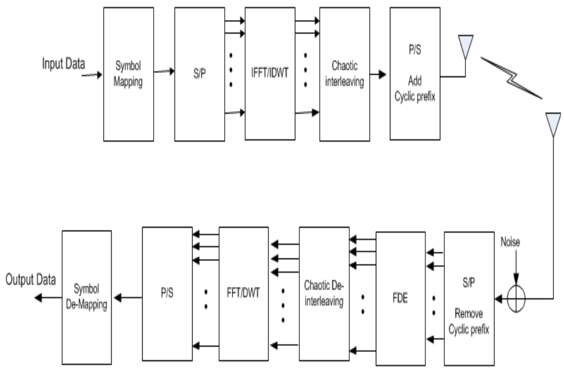

Figure 2.2: Block diagram of the proposed system model.

At the receiver, the process is reversed. Since the data is processed to the chaotic de-interleaving, the receiver is assumed to have an ideal knowledge of the secret key of the chaotic map.

2.3 CHAOTIC BAKER MAP

The channel errors caused by the mobile wireless channels are bursty in nature, interleaving is a must in mobile communication systems. Several interleaving schemes have been proposed. The simplest and most popular of such schemes is the block interleaver scheme, but this interleaver is not efficient with 2-D error bursts.

As a result, there is a need for advanced interleavers for this task. The 2-D chaotic Baker map in its discretized version is a good candidate for this purpose. In the system model after (IFFT/IDWT), the signal samples can be arranged into a square matrix then randomized using the chaotic Baker map.This paper presented a chaotic interleaving scheme to be used with OFDM systems to reduce the channel effect.

Chaotic interleaving of an $N \times N$ square matrix can be summarized as follows:

1. An N X N square matrix is divided into k vertical rectangles of height N and width ni such that n1 + n2 …..+ nk = N.

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2. These vertical rectangles are stretched in the horizontal direction and contracted vertically to obtain an ni X N horizontal rectangle.
3. These rectangles are stacked as shown in Figure (2-a), where the left one is put at the bottom and the right one at the top.
4. Each vertical rectangle ni X N is divided into ni boxes of dimensions N/ni X ni containing exactly N points.
5. Each of these boxes is mapped column by column into a row of data items as shown in Figure (2-b).

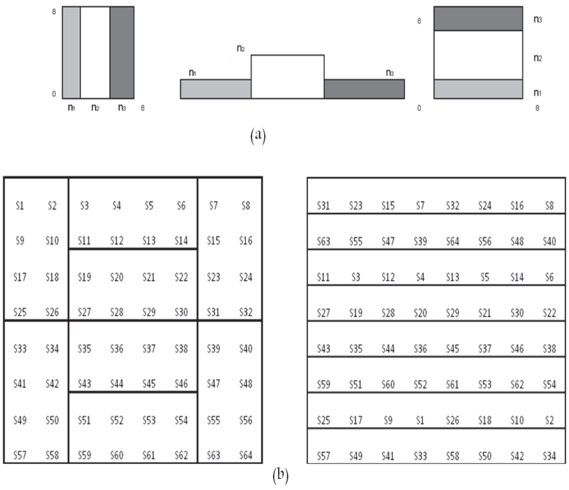

Figure 2.3: Chaotic interleaving.

(a) Discretized Baker map. (b) Randomization of an 8 × 8 block.

Figure 2.3 shows an example of chaotic interleaving of an (8×8) square matrix. The secret key, (n1, n2, n3) = (2,4,2).

Results and discussion

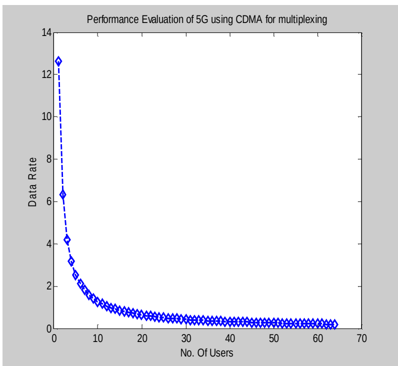

Figure 3.1 Performance evaluation of 5G using CDMA for multiplexing.Graph shows data rate vs no. of users.

The above graph shows a relationship between performance evaluation of 5G using CDMA for multiplexing. So finally from the graph it is clear that with the increase in number of users the data rate decreases and the graph varies with the change in number of users.

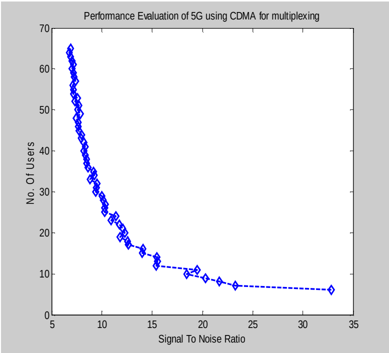

Figure 3.2 Performance evaluation of 5G using CDMA for multiplexing.Graph shows Signal to noise ratio vs no. of users.

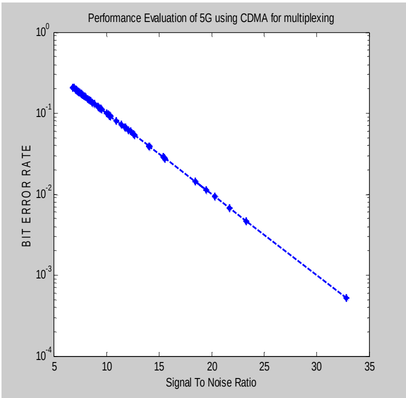

Figure 3.3 Performance evaluation of 5G using CDMA for multiplexing.Graph shows Signal to noise ratio vs bit error rate.

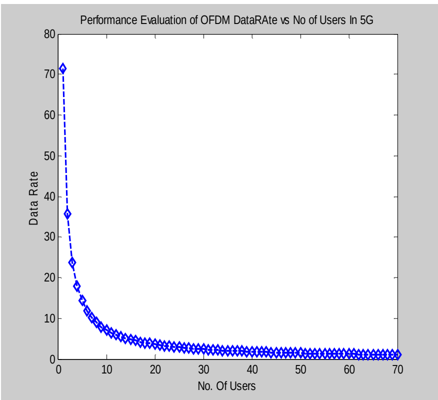

Figure 3.4 Performance evaluation of 5G using OFDM for multiplexing. Graph shows data rate vs. no. of users

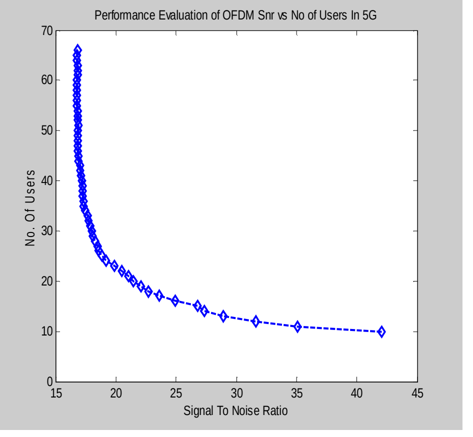

Figure 3.5 Performance evaluation of 5G using OFDM for multiplexing. Graph shows SNR vs. no. of users.

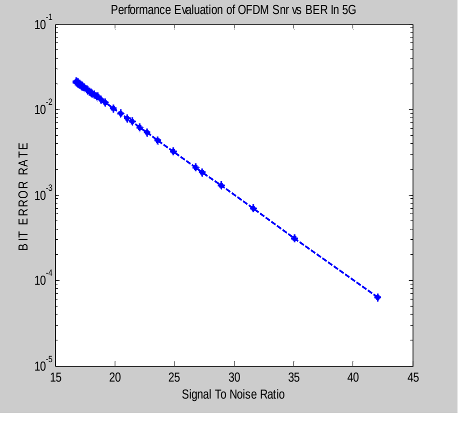

Figure 3.6 Performance evaluation of 5G using OFDM for multiplexing. Graph shows SNR vs. Bit error rate.

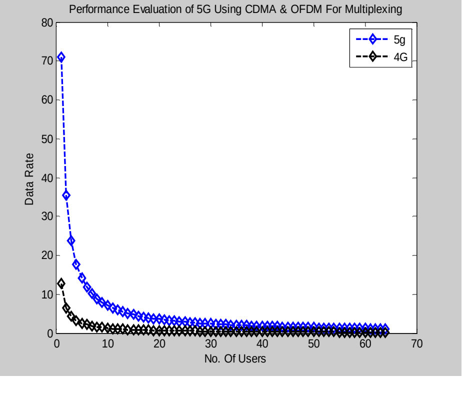

Figure 3.7 Performance evaluation of 5G using OFDM and 5G using CDMA for multiplexing. Graph shows Data rate vs no. of users.

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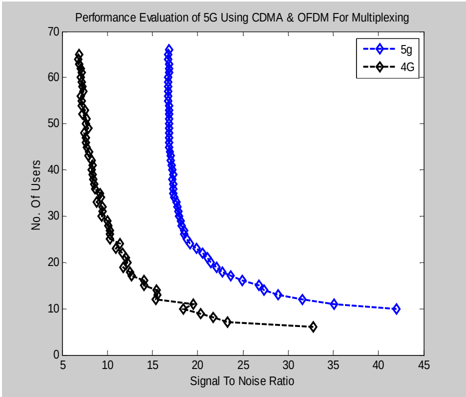

Figure 3.8 Performance evaluation of 5G using OFDM and 5G using CDMA for multiplexing. Graph shows SNR vs no. of users.

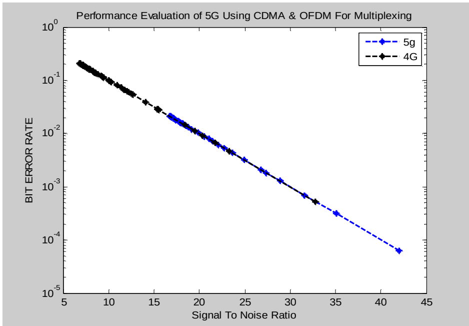

Figure 3.9 Performance evaluation of 5G using OFDM and 5G using CDMA for multiplexing. Graph shows BER vs SNR

4.1 Conclusion

The present research is that OFDM appease to be better technique as a modulation technique in 5G wireless networks. An OFDM link had been confirmed to work by using computer simulations. The performance criteria that had been tested is spectral efficiency. It was found that CDMA only performs well in a multi-cellular environment where a single frequency is used in all cells. This increases the comparative performance against other systems that require a cellular pattern of frequencies to reduce inter-cellular interference.

OFDM was found to perform very well compared with CDMA, with it out-performing CDMA in many areas for a single and multicell environment. OFDM was found to allow up to 2 - 10 times more users than CDMA in a single cell environment and from 0.7 - 4 times more users in a multi-cellular environment. The difference in user capacity between OFDM and CDMA was dependent on whether cell sectorization and voice activity detection is used.

5.1 Future work

This paper has concentrated on OFDM, however most practical system would use forward error correction to improve the system performance. Thus more work needs to be done on studying forward error correction schemes that would be suitable for telephony applications, and data transmission.

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