4G: An Emerging Mobile Telecommunication Technology

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***Abstract*-The aim of this paper is to identify and explore the various issues and challenges of 4G wireless networks. The fourth generation (4G) is a conceptual framework and a discussion point to address future needs of a high speed wireless network that can transmit multimedia and data to and interface with wire-line backbone network perfectly just raised in 2002.At first it gives a brief introduction and after that it focuses on the vision and implementation of 4G, it mainly explains the use of 4G having possessed "3G" and discusses various advantages and disadvantages. Then it compares 4G with other generations. It also put some light on the implementation part of 4G which uses orthogonal frequency division multiplexing (OFDM).**

I. INTRODUCTION

In a world of fast changing technology, there is a need for people to communicate and get connected with each other and they should have appropriate and timely access to information independently of her or his location, in an almost transparent way. The massive demands and requirements to access multimedia components through wireless mobile communication systems have led to the need for the design of highly-capable wireless telecommunication systems.

Wireless mobile communications systems are uniquely identified by "generation designations[4]. In the present time, there are four generations in the mobile industry. These are respectively 1G the first generation, were marked by analog frequency modulation and used primarily for voice communications, 2G the second generation were also used mainly for voice transmission and reception, is associated with Global System for Mobile (GSM) service. Between 2G and 3G there is another generation called 2.5G. 3G the third generation, are designed for voice and paging services, as well as interactive multimedia use such as teleconferencing, Internet access, and other services. Here the data are sent through the technology called Packet Switching .Voice calls are interpreted through Circuit Switching. and then the 4G the fourth generation. As compare to 3G it offers higher data rates and the ability to roam across multiple heterogeneous wireless networks. It has some additional features such as Multi-Media Newspapers, also to watch T.V programs with the clarity as to that of an ordinary T.V. In addition, we can send Data much faster than that of the previous generations.

Now 2G and 3G are well-established as the mainstream mobile technology around the world. 3G is stumbling to obtain market share for a different reasons and 4G is achieving some confidence.

In present scenario multimedia services are playing an important role and dominating the cellular traffic. In such a scenario, the present 2G and 3G systems will saturate and have no room to survive. Also, the demand for improved data rates leads to higher bandwidth requirements. These factors force the cellular industry to develop a common standard or system that over comes almost all limitations imposed by previous cellular technologies.

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.

II. FEATURES OF 4G

- It will have the ability to access to applications ranging from basic voice communications to seamless real-time streaming video.
- High speed, high capacity, and low cost.
- Ad hoc and multi hop networks.
- IP based mobile system.
- Better spectral efficiency and Scheduling.
- Global access, service portability, and scalable mobile services.
- Seamless network of multiple protocols and air interfaces.

III. WORKING PRINCIPLE

The future 4G architecture will consist of various networks using Internet Protocol (IP) as a common

protocol. This IP will be formed by a permanent home IP address and a dynamic care-of address that represents its actual location. When a device (computer) wants to communicate with another device (cell phone) in the wireless network, the computer will send a packet to the 4G-IP address of the cell phone targeting on its home address. Then a directory server on the cell phone's home network will forward this packet to the cell phone's care-of address through a tunnel, mobile IP; moreover, the directory server will also inform the computer that the cell phone's care-of address (real location), so next packets can be sent to the cell phone directly. The idea is that the 4G-IP address (IPv6) can carry more information than the IP address (IPv4).[1]

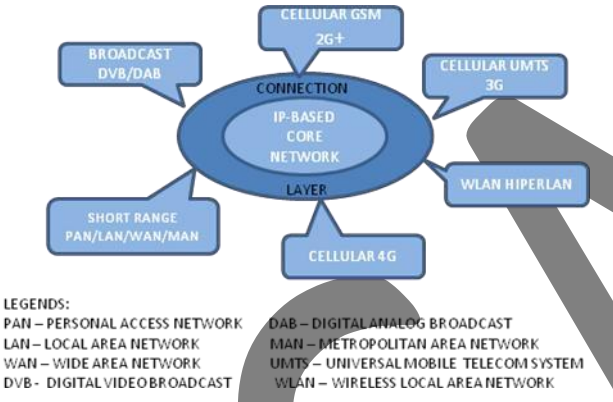


Fig.1.: Seamless connection of networks

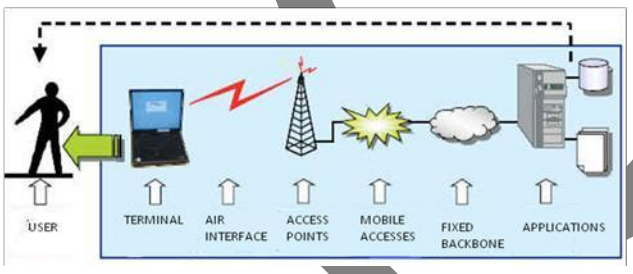


Fig.2: 4G Mobile Communication

In 4G systems regarding multiplexing OFDM is used as compared to CDMA/TDMA because CDMA, systems could use multicodes and adaptive interference cancellation which again raise complexity issue. OFDM is one of those techniques which are proposed for this next generation wireless communication systems .

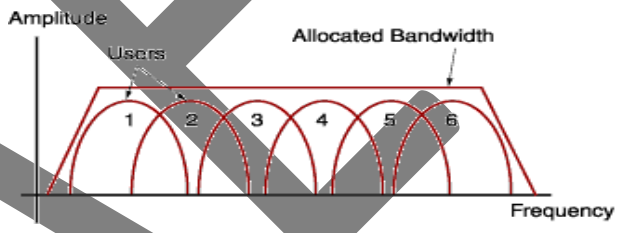
IV . OFDM

OFDM (Orthogonal Frequency Division Multiplexing) is a special case of Frequency Division multiplexing (FDM).

OFDM is a technology that allows transmitting very high data rates over channels at a comparable low complexity. It is a Successor to Frequency Hopping and Direct Sequence CDMA. OFDM's spread spectrum technique spreads the data over a lot of carriers that are spaced apart at precise frequencies.

OFDM can also be as a multiple access technology (Orthogonal Frequency Division Multiple Access; OFDMA)[2]. In this case, each OFDM symbol can transmit information to/from several users using a different set of subcarriers (sub channels). This not only provides additional flexibility for resource allocation (increasing the capacity), but also enables cross-layer optimization of radio link usage.

And now days it is being increasingly used in high -speed information transmission systems like: European HDTV , Digital Audio Broadcast (DAB), Digital Subscriber Loop (DSL), IEEE 802.11 Wireless LAN



This spacing provides the "orthogonality" in this method which prevents the receivers/demodulators from seeing frequencies other than their own specific one.

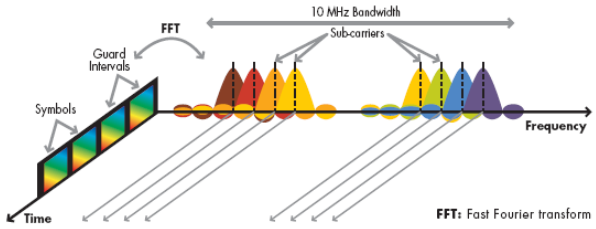


Fig.3: OFDM Principles

As shown in the fig. the signal is split into orthogonal sub carriers, on each of which the signal is –narrowband‖ (a few KHz) and therefore immune to multipath effects, Provided a guard interval is guarded between each OFDM symbol. OFDM also provides a frequency diversity gain increasing the physical layer performance. It is also compatible with other enhancement technologies, such as smart antenna and MIMO.

V. OFDM CHARACTERISTICS

- High peak-to-average power levels.
- Enables efficient TX and R diversity.
- Robust against narrow band interference.
- Support dynamic packet Access.
- Dynamic or variable bandwidth.
- Used for high speed applications.
- Adaptive antenna arrays without joint Equalization.

VI. OFDM BENEFITS

- High-spectral efficiency.
- Resistance to frequency selective fading.

VII. ADVANTAGES OF 4G

- Support for interactive multimedia services like teleconferencing and wireless Internet.
- Seamless Mobility (roaming).
  - Roam freely from one standard to another.
  - Integrate different modes of wireless communication- indoor networks(e.g. wireless LANs and Bluetooth); cellular signals; radio and TV; satellite communications.
  - 100 Mb /se full mobility (wide area); 1 Gbit/s low mobility (local area).
- IP-based communications systems for integrated voice, data, and video.
  - Maintain several data streams within a single connection.
  - Service Location Protocol (SLP).
  - Automatic resource discovery.
  - Make all networked resources dynamically configurable through IP-based service and directory agents.
  - Entirely packet switched networks.
  - Higher band widths to provide multimedia services at lower cost (up to 100 Mbps).
- Tight network security.

VIII. LIMITATIONS

Although the concept of 4G communications shows much promise, there are still limitations that must be addressed.

- A major concern is interoperability between the signaling techniques that are planned for use in 4G (3XRTT and WCDMA).
- Cost is another factor that could hamper the progress of 4G technology. The equipment required to implement the next-generation network are still very expensive.
- A Key challenge facing deployment of 4G technologies is how to make the network architectures compatible with each other. This was one of the unmet goals of 3G.

IX. COMPARISIONS OF DIFFERENT GENERATION[3]

Table 1 : Comparison of 4G with other Mobile Telecommunication Technologies

Technology	1G	2G	2.5G	3G	4G
Design Began	1970	1980	1985	1990	2000
Implementation	1984	1991	1999	2002	2010
Services	Narrow band analog voice calls and can send text messages	Narrow Band Wireless Digital Network, roaming facility	Higher capacity, Packetized data	Wide Band Voice Channel, Global Roaming, Video Conferencing, Video Calls, MMS	Multi-Media Newspapers, Mobile TV
Bandwitdth	1.9 Kbps	14.4 Kbps	384 Kbps	2 Mbps	2 00 Mbps
Multiplexing	FDMA	TDMA	TDMA,CDMA	CDMA	OFDM
Switching	Circuit Switched	Circuit Switched	Circuit Switched	Packet Switching, Circuit Switching	packet Switched network
Standards	AMPS, TACS and ETACS	GSM, CDMA, TDMA and EDGE	CDMA ,GPRS and 1xRTT	UMTS, WCDMA and HSPDA	3G C-CDMA, LAS-CDMA, UWB *7 and Network-LMD
Data Rate	2.4Kbps	64kbps	172Kbps	Up to 2Mbps (384 kbps WAN)	Up to 1Gbps

LEGENDS:

XRTT – 2.5G cdma data service up to384 kbps
AMPS - Advance Mobile Phone Service
EDGE – Enhanced Data For Evolution
GPRS – General Packet Radio System
TACS – Total Access Communication System
WCDMA – Wide band CDMA
HSPDA - High-Speed Downlink Packet Access
GSM - Global System for Mobile
CDMA – Code Division Multiple Access
FDMA – Frequency Division Multiple Access
TDMA – Time Division Multiple Access
OFDMS-Orthogonal Frequncy Division Multiple Access
UMTS - Universal Mobile Telecommunications System

X. CONCLUSION

As the history of mobile communication shows lots of attempts have been made to reduce a number of technologies to single global standard .Future wireless networks will need to support diverse IP multimedia applications to allow sharing of resources among multiple users. There must be low complexity of implementation and an efficient means of negotiation between the end users and the wireless infrastructure. the fourth generation promises to fulfill the goal of PCC (personal Computing communication) - a vision that affordably provides high data rates everywhere over a wireless network .The world is looking forward for the most intelligent technology that would connect the entire globe which was expected to be launched by 2010 .but It is always dangerous to predict too far ahead in a fast- moving field such as mobile communications. Almost by definition the eventual 2010 scene will not match exactly that depicted in the 4G vision described herein. However, the key elements—fully converged services, ubiquitous mobile access, diverse user devices, autonomous networks and software dependency—will persist.

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