3G, 4G AND 5G WIRELESS MOBILE NETWORKS: A COMPARATIVE STUDY

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ABSTRACT

Mobile wireless cellular communication is one of the hottest area that are developing a high speed wireless networks with advanced technologies. A mobile wireless network is a radio network technology. Mobile wireless technology have made a tremendous growth in the last 15 years. Now a days, mobile handheld device has become the most common tool of communication. The Wireless technology of mobile communication is started from first generation and reached up to fifth generation[1]. In this paper we deal with the comparative study of third generation (3G), fourth generation (4G) and the Fifth generation (5G). The comparison between these wireless communication system in relations to its frequency, architecture, standards, basic tools, switching designs, speed, and its technical specification as well as its features and discovered their performance to solve the problems of poor coverage, poor quality of service, bad interconnectivity and improve in the technology. The main objective of this study to evaluate a fast and effective mobile wireless devices for connections and communication, including the compatibility of supporting and allowing high frequency wireless communication.

Keyword: Mobile Wireless Network, 3G, 4G, 5G Cellular Network

I. INTRODUCTION

One of the most active areas of technology development is Wireless Communication of our time. The transformation of what has been supporting voice telephony into a medium for supporting other services leads development in technological areas such as the transmission of data, text, images, and videos[2][3]. Thus, new wireless capacity's demand started growing at a very rapid pace just as in 1990s demand for wire line capacity increased. Day by day, Increasing variety of user-friendly widespread wireless technologies and wider availability of open source tools for content generation, multimedia-enabled terminals has lead encouraged user-centric networks, which results into a need for efficient design for network. There has been a shift to mobile cellular telephony from fixed, results into Network Planning and Optimization related services coming in to sharp focus. Due to evolution of wireless access, technology reaches about its fourth generation. In the last fifteen years, Wireless networks and mobile have made tremendous growth. Now a days, many mobile phones are equipped with a WLAN adapter. Besides their 4G, 3G, WLAN, and Bluetooth adapters, many mobile phones will have WiMAX adapter in the near future, On one side, Using IP for both 2.5G and 3G Public Land Mobile Networks (PLMN) and on the other to raised research on their integration WLAN is used. Regarding the 4G, its focus is towards seamless integration of cellular networks such as 3G and GSM. In 4G, multimode

user terminals are seen, but different security mechanisms with different QoS support in different wireless technologies remains a great challenge. However, even today integration among different wireless networks (e.g. WLMN and PLAN) is functioning in practice, with different wireless networks from a single terminal being used exclusively; i.e., there is no combination of different wireless access technologies for a same session (e.g. FTP download)[4]. The 5G (or beyond 4G) systems will be capable of supporting the www allowing a highly flexible network in evolutionary view, such as a Dynamic Adhoc Wireless Network (*DAWN*). Flexible modulation and advanced technologies including intelligent antenna are keys to optimize the adhoc wireless networks. In revolutionary view, 5G systems would be an intelligent technology capable of interconnecting the entire world without limits in the view of revolutionary. A robot, is an example application, with in-built wireless communication with artificial intelligence [5].
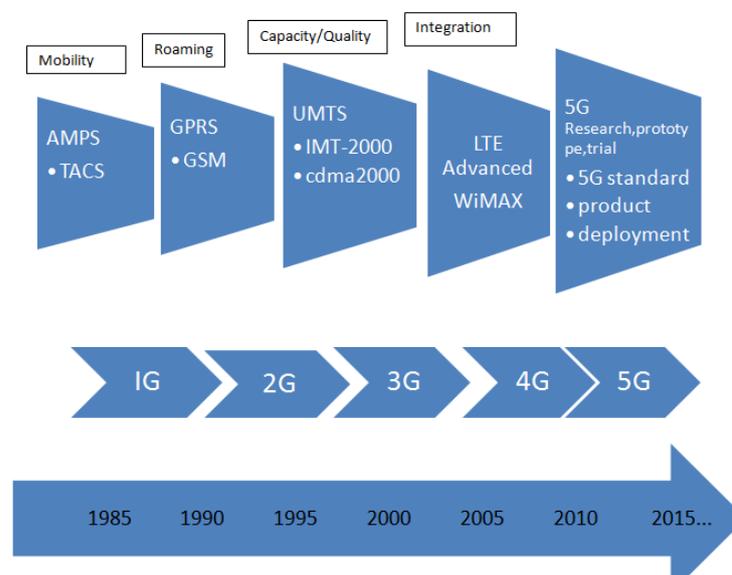

Figure 1: Mobile Cellular Network Evolution Timeline

II. WIRELESS MOBILE NETWORK STUDY

2.1 Third Generation (3g)

3G is the third generation mobile wireless technology. Technically we can say that 3G is a network protocol which refers the generation of mobile and its equipment, which are compatible with IMT-2000 standard specification by the International Telecommunication Union (ITU). There should be at least 200Kb/s data rates for compiling the IMT-2000 standards. 3G functions in the range of 2100Hz and bandwidth 15-20 MHz.[6] The most important fact of 3G technology is the CDMA, GSM and TDMA standards are under one roof. There are basically three air interface modes for accomplished the 3G wireless technology. [7]

There are three basic air interface modes for accomplish the 3G wireless technology.

1. Wideband CDMA (W-CDMA)
2. CDMA-2000
3. UWC-136 (Universal Wireless Communication)

- **W-CDMA**: this is the most common deployment for 3G wireless network. This wireless standard commonly operated on 2100MHz frequency band, as well as on 850,900 and 1900 MHZ bands.

- HSPA is the combination of several upgraded W-CDMA standards and provide 14.4 Mb/s down and 5.76 Mbit/s up speed.

- HSPA+ is upgraded and revised version of HSPA, it provide highly speed data rates up to 168 Mbit/s down and 22 Mbit/s up. Using the combination of standard air interfaces improve the peak level data rate [8].

- **CDMA-2000:** This is also called IS-2000, including CDMA2000 and CDMA2000 1x high peak rate packet data, standardized by 3GPP2, include original IS-95 CDMA system that are especially used in India, Japan, North America, Europe and China.

- **UWC-136:**it is a TDMA radio interface designed to meet the basic requirements of 3G wireless system. UWC-136 was developed aiming at a maximum commonality between TIA/EIA-136 and GSM GPRS. There are four basic strategies to accomplished the 3G network evolution by TIA/EIA-136 i.e. 136+, 136 HS Indoor , 136 HS outdoor and 136 EHS. Firstly, 136+ is based on enhancement of voice and data capabilities of 30KHz channel. 136 HS Outdoor, based on improvement of a 200KHz carrier channels, inclusion of GPRS technology.[10] 136 HS Indoor is based on addition of 1.6MHz carrier component. 136EHS, based on the addition alternative 200KHz carrier components for high speed data (inclusion of EDGE technology).

Table : Overview of 3G Standards

ITU IMT-2000 compliant standards	Common name(s)	Bandwidth of data	Channel	Description	Historical areas
TDMA Single-Carrier (IMT-SC)	EDGE (UWC-136)	EDGE Evolution	TDMA	Evolutionary upgrade togsm/GPRS	Worldwide, except Japan and South Korea
CDMA Multi-Carrier (IMT-MC)	CDMA2000	EV-DO	CDMA	Evolutionary upgrade tocdmaone (IS-95)	Americas, Asia, some others
CDMA Direct Spread (IMT-DS)	W-CDMA	HSPA	None	Family of revolutionary upgrades to earlier GSM family.	Worldwide
CDMA TDD (IMT-TC)	TD-CDMA				Europe
	TD-SCDMA				Mainland China

					only
FDMA/TDMA (IMT-FT)	DECT	None	FDMA/TDMA	Short-range; standard for cordless phones	Europe, US, Canada
IP-OFDMA	None	Wimax (IEEE 802.16)	OFDMA		Worldwide, except mainland China

Source :wikipedia

2.2 Fourth Generation (4G)

4G stands for fourth generation of mobile telecommunication technology. 4G is succeeding 3G and preceding 5G. In India this is currently developed and is looking to be implemented in 2012 to 2015. In March 20008, the standard listed by the International Telecommunication Union-Radio Communication Sector (ITU-R) for 4G standards, are called the International Mobile Telecommunications Advanced (IMT- Advance). Since the WIMAX and LTE version support only less than 1GB/s peak bit rate. Both are not fully IMT-Advance complaint, but are often branded 4G by service provider[11].

There are some basic requirements for the IMT-Advances radio interfaces are:

- A rate of 1GB/s for low mobility communication (stationary users) and 100Mbps for high mobility communication.
- High Quality mobile communication services.
- Capability of World Wide roaming facility.
- Compatible with IMT ,WiMax and fixed networks.
- Inter-networking with other radio access technology.

On Dec. 6, 2010, 4G commonly observed by industry are the Wi-Max 2 and LTE-Advanced network which will gives faster and higher speed of internet services in the future. The ITU-R is looking for a network technology system that has high interoperability between mobile hand held devices and that can maintain a peak frequency data exchange rate between computers and technologies[12]. The two new technologies that could possibly qualify as 4G are the Wi-Max 2 and LTE-Advanced networks.

- **LTE :**LTE-Advanced stands for Long Term Evolution Advanced, is a mobile network technology standard that offers higher throughput than is predecessor. Radio Access network is one of the component of LTE Advanced network, allow to achieve high capacity rates [13].

The following technologies involved with the LTE Advanced system.

- **Orthogonal Frequency Division Multiplexing:** (OFDM) this is the basis of radio bearer, including the Orthogonal Frequency Division Multiple Access (OFDMA) and Single Channel Orthogonal Frequency Division Multiple Access (SC-QFDMA). OFDM is a form of transmission, uses a large number of carriers that are modulated with low frequency rate. It decrease the amount of interface of the signals which also reduce the amount of delay between channels.

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- **Multiple Input Multiple Output, MIMO:** The other feature of LTE Advanced is MIMO. A radio technology that increased the performance by using multiple antennas for transmitters and receivers. MIMO is also used by many technologies like as Wi-Max and Wi-Fi- 802.11n.

- **Carrier Aggregation, CA:** For those operators do not have proper contiguous spectrum to gives the minimum required bandwidths for high speed data rates, for develop the Carrier aggregation. CA technology operators are able to multiple channels either in the same bands and provide the required bandwidth.

- **LTE Relaying:** This is a scheme that enable wireless signals to be forwarded by remote stations from a base station to improve the coverage area or signals.

- **WIMAX :**Wi-Max stands for worldwide interoperability for microware access, a wireless communication standard developed to gives 30 to 40 Mbps data rate for communication. In 2011, the improved version of WIMAX is developed. called WiMax-2. This is based on the IEEE 802.16m standard, which is an improved version of IEEE standard 802.16e. currently, this technology is being worked on by Samsung, Intel and Motorola to make it 4G Compatible. During the trail runs by Samsung, this technology has actually hit 330 Mbps downloading speed [14]. The specification of WiMax-2 are built on the institute of Electrical and Electronics Engineers 802.16m standard. It include high air competency.

Wi-Max 2 specifications:

- The WiMax technology has some technical specification that will make it faster than other network.

- WiMax 2 standard can deliver 120Mb/s down and 60Mb/s up without any restriction.

- Wimax 2 technology used MIMO support antennas with 20 MHzchannel that enable signals everywhere.

- IEEE 802.16m standard carrier to 100MHz of bandwidth and allows for the use of super frames.

- WiMax 2 network speed will be very fast and user can do much before.

- With the help of WiMax 2, the data, voice and video transmission are the clear efficiency.

- WiMax supports Time Division Duplexing (TDD) and Frequency Division Duplexing (FDD), both provides low cost accomplishment [15].


2.3 Fifth Generation (5G)

5G, Fifth Generation wireless system denotes the future of the mobile telecommunication technology. The 5G mobile networks alliance defines the following requirements are given below:

- 5G is not a term that is being used for any official document or specification yet made public by telecommunication companies or other bodies like 3GPP, Wi MAX Forum or ITU-R.

- 5G technology stands for 5th generation mobile technology.

- 5G technology offer high resolution.

- It provides advanced billing interfaces.

- It provides large broadcasting of data that supports almost 65,000 connections.

- A user can get better and fast solution through remote management that is offered by 5G technology.

- It is providing up to 25 Mbps connectivity speed.

- It supports virtual private network.

- Uploading and downloading speed of 5G technology is far more superior to 3G and 4G technology.

- 5G technologies have an extraordinary capability to support Software and consultancy.

- It provides high connectivity as it uses router and switch technology.

- 5G technology has a growing feature.

- In the 5G technology, World Wide Wireless Web (WWWW), wireless-based web applications.

- Compatible Full multimedia accessibility.

- Applications cumulative with Artificial Intelligent (AI).

- Not harmful to human health.

- Less traffic fees due to low infrastructure deployment costs.

- Smart beam antenna systems.

2.4 5G Architecture

5G technology is entirely IP based model that is designed for wireless and mobile networks. The whole system comprises of main user terminal and a number of independent radio access technologies. Each of the independent radio technology is considered to be as the IP link for the outer internet world [16]. 5G technology is combination of technologies that are mentioned below:
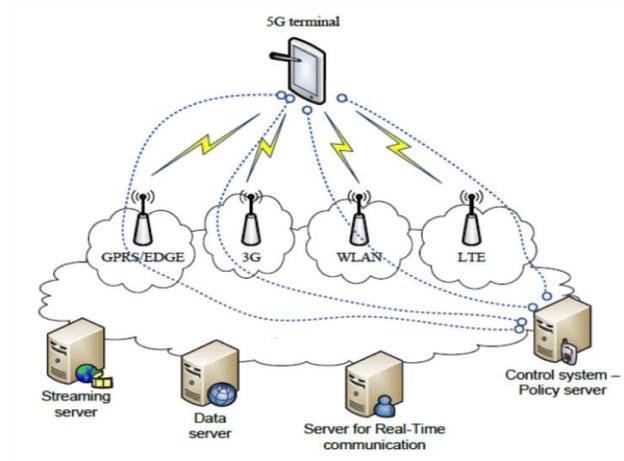
- Nanotechnology
- Cloud computing
- All IP platform
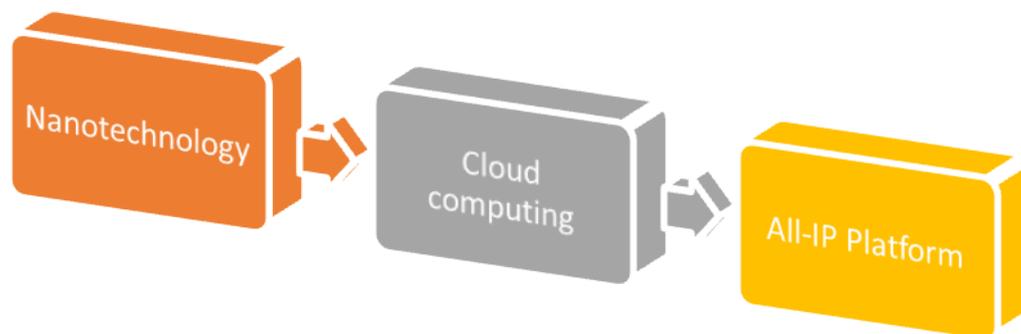
III. NANOTECHNOLOGY

- Nanotechnology is the engineering of functional systems at the molecular scale.

- Nanotechnology is an application of nano science that can handle process on nano meter scale that varies from 0.1 to 100nm.

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- This technology was introduced by Taniguchi in 1974 at the Tokyo international conference.
- Sometimes It is referred as general purpose technology.it can work in many applications like communication, medical, transportation, agriculture, home products [17].

3.1 Cloud Computing

- It is an internet based computing which works on sharing different computing resource.
- Cloud computing focuses on maximizing the effectiveness of the shared resources.
- Cloud resources can be shared by multiple users as well as these can be available on demand.
- Its best example is Gmail where you can store your data like documents, music, pictures, videos etc. and can share it with anybody you want.
- Cloud computing solves out the problem of carrying a storage device. A user can access data anytime at any place [18].

3.2 All Ip Network

- An all-IP network is simply a packet-based network in which all data is transferred the same way and independent of the access or transport technology.
- It supports generalized mobility which will allow consistent and ubiquitous provision of services to users.
- It offers unrestricted access by users to different service providers.
- In the Core network, the voice service must be moved from circuit-switching to VoIP and ISDN migrated to All-IP [19].
- In wired network, the VoIP must be integrated with digital subscriber line access multiplexers and voice switching infrastructure must be eliminated [20].
- In the cable network, enable VoIP and SIP services after migrated to packet cable standards.

IV. COMPARATIVE STUDY OF VARIOUS WIRELESS GENERATIONS

Technology	3G Network	4G Network	5G Network
Evolution	2002	2010	2015-2020
Data Rate Speed	2Mbps	200Mbps to 1Gbps	More than 1Gbps
Frequency Band	850/900/2100MHz	2-8 GHz	3-300 GHz
Standard	IMT-2000 3.5G-HSDPA 3.75G-HSUPA	Single Unified Standard LTE/LTE Advance Wi-Max, Wi-Fi	Single Unified Standard
Web Standard	Www(IPv4)	Www(IPv4)	Wwww(IPv6)
Hand-off	Horizontal	Horizontal and Vertical	Horizontal and Vertical
Technology	Digital Broadband Packet Data **Throughput** 3G : 200Kbps 3.5G : 1-3 Mbps	Digital Broadband Packet All, Very High Throughput **Throughput** 100-300Mbps	Proposed: Unified IP and seamless combination of broadband, Local area networks, wide area networks, personal area networks, wireless LAN
Services	Integrated Higher Quality audio, Video and data.	Dynamic Information Access, Wearable devices	Dynamic Information Access, wearable device with IA capabilities
Switching	Packet except circuit for air interface	All Packet	All Packet
Core Network	Packet network	Internet	Internet
Multiple Access	CDMA	CDMA	CDMA & BDMA
Features	Fast data transfer rate, Improved spectral efficiency, greater network capacity.	Converged data and voice over IP Entirely packet switched network, Higher bandwidth to provide multimedia services at lower cost (up to 100Mbps)	Simultaneous access to different wireless technologies -complete wireless communication (Wireless world wide web, WWWW)
Shortfalls	Need to accommodate higher network capacity	Being deployed	Yet to be implemented
Network Architecture	Wide area Cell-based	Hybrid: Integration of wireless LAN and wide area	Open wireless Architecture

Table: 3G, 4G and 5G Mobile Network Comparison

V. CONCLUSION

In this paper, we have discuss the evolution of 3G, 4G and 5G mobile technologies and also comparison of various technologies like as network architecture, core network, switching, web standards, frequency band, data rates etc. and we concluded that it is the need for development of different protocols and standards for great connectivity are error less services. There are lots of improvements from 1G to 5Gwireless technology. 5G is the latest wireless technology like as nanotechnology, cloud computing, All-IP framework and high data rates provides great connectivity for future mobile network. The idea of keeping the wireless network more simple and provide more functionalities to the terminals will become reality in future generation of wireless mobile network technology.

REFERENCES

[1.] G. Abdullah, L. Xichun, Lina Yang, Omar Zakaria, and NorBadrulAnuar, Multi-Bandwidth Data Path Design for5GWireless Mobile Internets, 6(2), ISSN: 1790-0832. 2009

[2.] F.G. Bria, 4th Generation Wireless Infrastructures: Scenarios and Research Challenges, IEEE Personal Communications, 8(1), 2010

[3.] T. Janevski,5G Mobile Phone Concept, Consumer Communications and Networking Conference, 6th IEEE [1-4244-2308-2], 2009

[4.] W. W. Lu, An Open Baseband Processing Architecture for Future Mobile Terminals Design, IEEE Wireless Communications,2008

[5.] H. Honkasalo, WCDMA and WLAN for 3G and Beyond,IEEE Wireless Communications, 9(2), 2002, 14 – 18.

[6.] M. Zeng, A. Annamalai, V.K. Bhargava,Recent Advances in Cellular Wireless Communications,IEEE Communications Magazine, 37(9), 1999, 128-138.

[7.] J. Ibrahim, 4G Features," Bechtel Telecommunications Technical Journal, 1(1), 2002, 11-14.

[8.] R. Berezdivin, R. Breinig, and R. Topp, Next Generation Wireless Communications Concepts and Technologies,IEEE Communications Magazine, 40(3), 2002, 108-116.

[9.] R. Berezdivin., and W.W. Lu,Technologies on Fourth Generation Mobile Communications, IEEE Wireless Communications, 9(2), 2002, 8-71

[10.] T.S. Rappaport, A. Annamalai, R.M. Buehrer, and W.H. Tranter, Wireless Communications: Past Events and a Future Perspective," IEEE Communications Magazine, 50th Anniversary Issue. 2002

[11.] F. Williams, Ericsson, "Fourth generation mobile," in *ACTS Mobile Summit99*, Sorrento, Italy, June 1999.

[12.] H. Huomo, Nokia, "Fourth generation mobile," in *ACTS Mobile Summit99*, Sorrento, Italy, June 1999.

[13.] Jun-Zhao Sun, JaakkoSauvola, and Douglas Howie, "Features in Future: 4G Visions From a Technical Perspective,"in IEEE, 2001.

[14.] Mishra, Ajay K. "Fundamentals of Cellular Network Planning and Optimization, 2G/2.5G/3G…Evolution of 4G", John Wiley and Sons, 2004.

[15.] Pereira, Vasco & Sousa, Tiago. "Evolution of Mobile Communications: from 1G to 4G", Department of Informatics Engineering of the University of Coimbra, Portugal 2004.

[16.] Jeffrey G. Andrews, Stefano Buzzi, Wan Choi, Stephen V. Hanly, Angel Lozano, Anthony C. K. Soong, Anthony C. K. Soong, Jianzhong Charlie Zhang, " What Will 5G Be?," in Vol. 32, No. 6, IEEE Journal on selected Areas in Communications, JUNE 2014.

[17.] Gokul P Nair, " Nanocore- A Review on 5G Mobile Communications," in pg. 124-133, ISSN 2320–088X, International Journal of Computer Science and Mobile Computing, ICMIC13, December- 2013.

[18.] Dr. Anwar M. Mousa, "Prospective of Fifth Generation Mobile Communications," in Vol.4, No.3, International Journal of Next-Generation Networks (IJNGN) ,September 2012.

[19.] Sapana Singh &Pratap Singh, "Key Concepts and Network Architecture for 5G Mobile Technology," in Volume1 Issue5, International Journal Scientific Research Engineering Technology (IJSRET), August 2012, pp165-170 .

[20.] T. Janevski, "Traffic Analysis and Design of Wireless IP Networks," in Artech House Inc., Boston, USA, 2003.