A Survey Report on Cellular Technology

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Abstract—Cellular technology is the foundation of mobile wireless communications and supports users in locations that are not easily served by wired networks. Cellular technology is the underlying technology for mobile telephones, personal communications systems, wireless Internet and wireless Web applications, and much more. This article looks at how cellular technology has evolved through four generations and is poised for a fifth generation.

Keywords- Cellular phones, 1G, 2G, 3G, 4G, 5G generations

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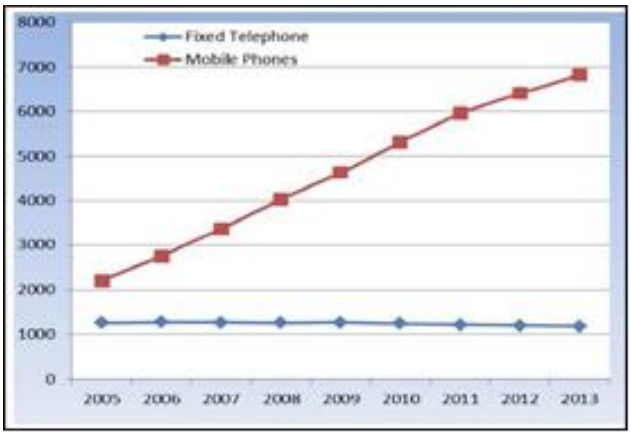
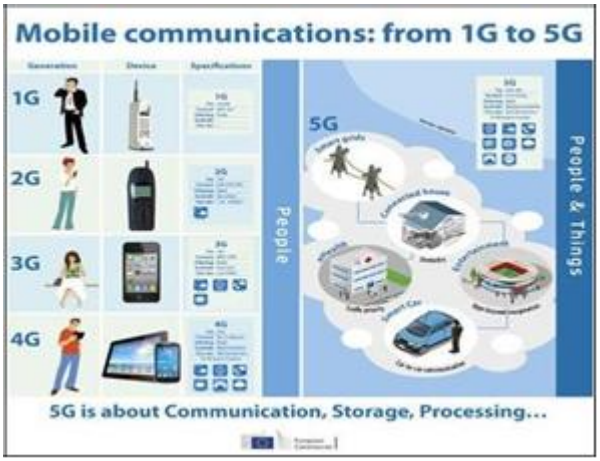
I. INTRODUCTION

The use of mobile/cellular phones is increasing in the last 8 years. The growth of mobile phones or cellar phone users is compared with fixed phones is shown in Figure 1. The number of users increased then the management of mobile phone phones becomes more complex. If the complexity and requirement increases then the new technologies with models are required to manage the system.



Cellular technology is the foundation of mobile wireless communications and supports users in locations that are not easily served by wired networks. Cellular technology is the underlying technology for mobile telephones, personal

Wireless access technology have formed different evolutionary path but with a common aim related to performance and efficiency. Nowadays many mobile phones have also a WLAN adapter. One may suppose that near soon many mobile phones will have WiMAX adapter too, besides their 3G, 2G, WLAN, Bluetooth etc. adapters. Mobile Communication from 1G to 5G is as shown below in Figure 2



The paper is organized in four sections followed by references. Section 2 describes each of the generations in detail. Section 3 gives a detailed comparison of all generations of cellular technology. Section 4 summarizes the paper

II. EVOLUTION FROM 1G TO 5G

1G, 2G, 3G & 4G ("G" stands for "Generation") are the generations of wireless telecom connectivity. 1G (Time Division Multiple Access and Frequency Division Multiple Access) was the initial wireless telecom network system. It has fulfilled the basic mobile voice. Cell phones received their first major upgrade when they went from 1G to 2G. This leap effectively took cell phones from analog to digital. 2G and 2.5G were versions of the GSM and CDMA connections. The Second generation has dealt with capacity and coverage.

Then 3G came, the new Wireless CDMA technology. It is the first wireless telecom technology that provides broadband-speed internet connection on mobile phones. The third generation focused for higher data rate, multimedia support and spread spectrum. 4G, which is also known as ―beyond 3G‖ or ―fourth-generation‖ cell phone

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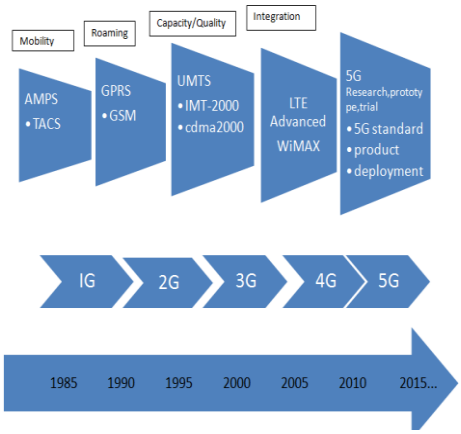
technology, refers to the entirely new evolution. Developers are now going for 4G (OFDMA), which will provide internet up to the speed of 1 GBPS!. Fourth generation providing access to wide range of telecommunication services including advanced mobile services, along with a support for low to high mobility application. By 5G should build an important role with more services, data, use and benefits to the upcoming generation over 4G. 5G will be smarter technology with no limits and to interconnect the whole world without limits. The upcoming life style will be different with uninterrupted access of information and interconnection.

Figure 3 reflects the evolution of network technologies.



A. 1G WIRELESS SYSTEM

They were analog based and evolved in early 80‘s. They were called AMPS --- Advanced Mobile Phone System, released in 1983 and employed in North and South America, China, Australia etc.Limitations of 1G systems : It as limited capacity, Low

calling capacity, No room for spectrum growth, Poordata communications, Minimal privacy, Inadequatefraud protection. Figure 4 indicates 1G handset.

Figure 4: 1G handset

B. 2G WIRELESS SYSTEM

2G cellular telecom networks were commercially launched on the GSM standard in Finland by Radio linja (now part of Elisa Oyj) in 1991. 2G technologies enabled the various mobile phone networks to provide the services such as text messages, picture messages and MMS (multimedia messages). 2G technology is more efficient. 2G technology holds sufficient security for both the sender and the receiver. They are based on digital technology. They are either TDMA or CDMA based. TDMA is used in GSM (Global System of Mobile Communication). Make use of CODEC (compression and multiplex algorithm) to compress and multiplex digital voice data. Hand sets are usually smaller, lighter and more robust. GSM has enabled the users to make use of the short message services (SMS) to any mobile network at any time. Figure 5 indicates 2G handset.

a. 2.5G WIRELESS SYSTEM

2.5G is a stepping stone between 2G and 3G cellular wireless technologies. The term "second and a half generation" is used to describe 2G-systems that have implemented a packet switched domain in addition to the circuit switched domain. It does not necessarily provide faster services because bundling of timeslots is used for circuit switched data services (HSCSD) as well.

The first major step in the evolution of GSM networks to 3G occurred with the introduction of General Packet Radio Service (GPRS). CDMA2000 networks similarly evolved through the introduction of 1xRTT. GPRS could provide data rates from 56 Kbit/s up to 115 Kbit/s. It can be used for services such as Wireless Application Protocol (WAP) access, Multimedia Messaging Service (MMS), and for Internet communication services such as email and World Wide Web access.

1xRTT supports bi-directional (up and downlink) peak data rates up to 153.6 kbps, delivering an average user data throughput of 80-100 kbps in commercial networks. It can also be used for WAP, SMS & MMS services, as well as Internet access.

b. 2.75G (EDGE)

GPRS networks evolved to EDGE networks with the

introduction of 8PSK encoding. Enhanced Data rates for GSM Evolution, Enhanced GPRS (EGPRS), or IMT Single Carrier (IMT-SC) is a backward-compatible digital mobile phone technology that allows improved data transmission rates, as an extension on top of standard GSM. EDGE was deployed on GSM networks beginning in 2003— initially by Cingular (now AT&T) in the United States. EDGE is standardized by 3GPP as part of the GSM family, and it is an upgrade that provides a potential three-fold increase in capacity of GSM/GPRS networks. The specification achieves higher data-rates (up to 236.8 Kbit/s) by switching to more sophisticated methods of coding (8PSK), within existing GSM timeslots.

C. 3G WIRELESS SYSTEM

The 3G[1] system represents convergence of 2G wireless systems into a single global system. International Mobile Telecommunications-2000 (IMT--2000), better known as 3G or 3rd Generation, is a generation of standards for mobile phones and mobile telecommunications services fulfilling specifications by the International Telecommunication Union. The dominant technology for 3G systems is CDMA. An important design goal for all 3G systems is to limit channel usage to 5 MHz. The use of 3G technology is also able to transmit packet switch data efficiently at better and increased bandwidth. Transmission speeds from 125kbps to 2Mbps .The objective of the third generation (3G) of wireless communication is to provide fairly high-speed wireless communications to support multimedia, data, and video in addition to voice. Data are sent through technology called packet switching .Voice calls are interpreted using circuit switching. Access to Global Roaming. In 2005, 3G is ready to live up to its performance in computer networking (WCDMA, WLAN and Bluetooth) and mobile devices area (cell phone and GPS). Figure 6 indicates 3G Handset.

Figure 6: 3G technology

D. 4G WIRELESS SYSTEM

4G refers to the fourth generation of cellular wireless standards [2]. The bandwidth and location information available to 3G devices gives rise to applications not previously available to mobile phone users. 4G systems provide ultra-broadband Internet access for a variety of mobile devices including laptops, smartphones, and tablets. 4G networks support Mobile Web access and high-bandwidth applications such as high-definition mobile TV, mobile video conferencing, and gaming services. 4G systems have the following characteristics:

- Based on an all-IP packet switched network.
- Support peak data rates of up to approximately 100 Mbps for high-mobility mobile access and up to approximately 1 Gbps for low-mobility access such as local wireless access.
- Dynamically share and use the network resources to support more simultaneous users per cell.
- Support smooth handovers across heterogeneous networks.
- Support high quality of service for next-generation multimedia applications

Figure 7: 4G wireless Technology

Figure 8 shows the basic concept of 4g network. The future 4G infrastructure will consist of a set of various networks using internet protocol [8].

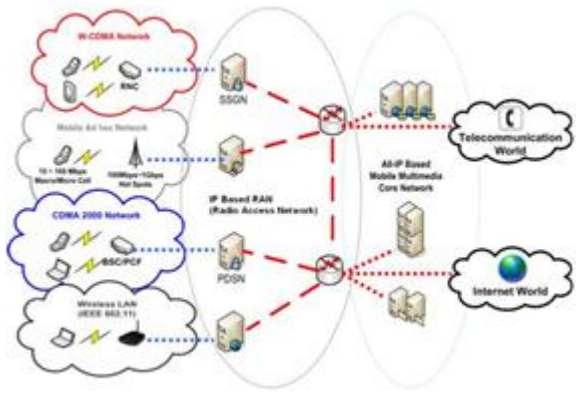


Figure 8: Concept of 4G network

An OFDM transmitter accepts data from an IP network, converting and encoding prior to modulation.An IFFT(inverse fast Fourier transform) transforms the OFDM signal into an IF signal, which is sent to RF transmitter. With orthogonal

sub-carriers, the receiver can separate and process each sub-carrier without interference from other sub-carriers. OFDM provides better link and communication quality. It is more impervious to fading and multi-path delays than other transmission techniques. . In addition to OFDMA, two other technologies are key to the deployment of 4G systems: multiple-input-multiple-output (MIMO) antennas, and the use of very small cells to augment the cell layout.

E. 2.7 5G Wireless System

The implementation of standards under a 5G umbrella would likely be around the year of 2020. 5G is a completed wireless communication with almost no limitation; somehow people called it REAL wireless world

Additional features such as Multi-Media Newspapers, also to watch T.V programs with the clarity as to that of an HD T.V. 5G will bring almost perfect real world wireless or called ―WWWW: World Wide Wireless

Web. Real wireless world with no more limitation with access and zone issues. Wearable devices with AI capabilities. Internet protocol version 6 (IPv6), where a visiting care-of mobile IP address is assigned according to location and connected network. One unified global standard. High altitude stratospheric platform station (HAPS) systems.

F. 5G TECHNOLOGY

The 5G terminals will have software defined radios and modulation schemes as well as new error-control schemes that can be downloaded from the Internet. The terminals will have access to different wireless technologies at the same time and the terminal should be able to combine different flows from different technologies. In 5G, each network will be responsible for handling user-mobility, while the terminal will make the final choice among different wireless/mobile access network providers for a given service. Such choice will be based on open intelligent middleware in the mobile phone.

a. 5G NETWORK ARCHITECTURE

5G architecture is shown in Figure 9.Fifth generation mobile systems model is all-IP based model for wireless and mobile networks interoperability[10]. The All-IP Network (AIPN) is capable to fulfill increasing demands of the cellular communications market. It is a common platform for all radio access technologies. AIPN uses packet switching and its continuous evolution provides optimized performance and cost. Network Architecture consist of a user terminal (which has a crucial role in the new architecture) and a number of independent, autonomous radio access technologies (RAT).

In 5G Network Architecture all IP based mobile applications and services such as Mobile portals, Mobile commerce, Mobile health care, Mobile government, Mobile banking and others, are offered via Cloud Computing Resources (CCR). CCR links the Reconfigurable Multi Technology Core (RMTC) with remote reconfiguration data from RRD attached to Reconfiguration Data models (RDM). RMTC is connected to different radio access technologies ranging from 2G/GERAN to 3G/UTRAN and 4G/EUTRAN in addition to 802.11x WLAN and 802.16x WMAN. Other standards are also enabled such as IS/95, EV-DO, CDMA2000...etc. Interoperability process-criteria and mechanisms enable both terminal and RMTC to select from heterogeneous access systems

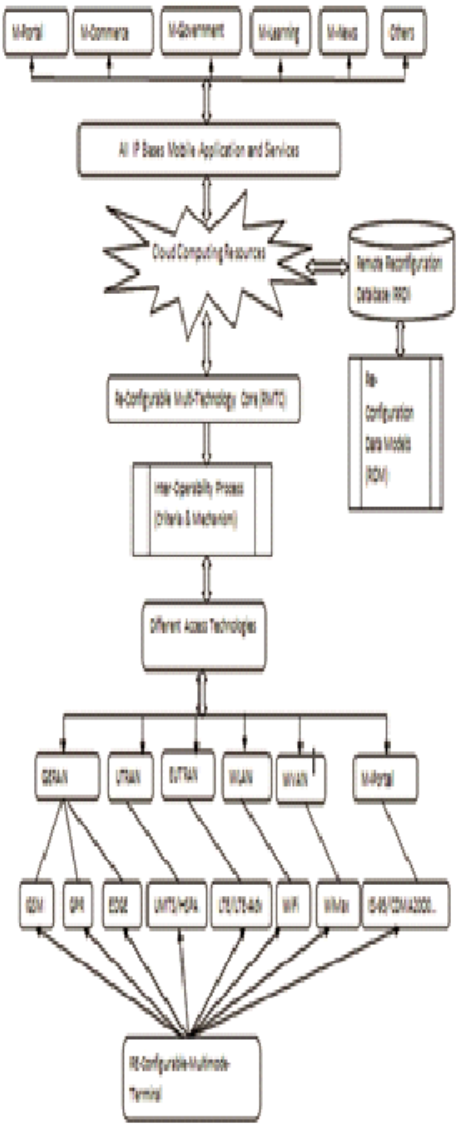


Figure 9: 5g network architecture[9]

b. OSI Layers in the 5G Mobile Terminal Design

Figure shows the OSI Layer model for 5G.

Application Layer	Application (Services)
Presentation Layer	
Session layer	Open Transport Protocol
Transport Layer	
Network layer	Upper network layer
	Lower network Layer
Datalink Layer	Open Wireless Architecture
Physical Layer	

Figure 10: OSI Layers in 5G

1. Physical Layer

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

2. 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. These issues are solved in IPv6, but traded with significantly bigger packet header. 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. 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.

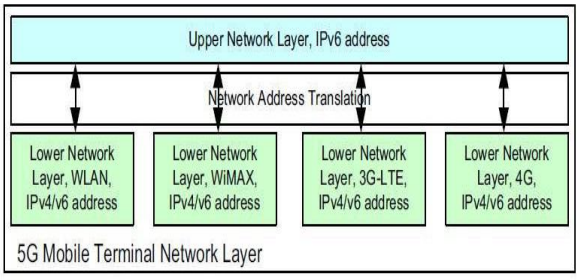


Figure 11 Terminal Network Layer

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.) i.e.: Lower network layer (for each interface) and Upper network layer (for the mobile terminal).This is shown above in figure11.

3. Open Transport Protocol (Ota) Layer

The mobile and wireless networks differ from wired networks regarding the transport layer. 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.

4. Application Layer

Regarding the applications, the ultimate request from the 5G mobile terminal is to provide intelligent QoS management over 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 QoS Parameters, such as delay, jitter, losses, bandwidth, reliability, will be stored in a database in the 5G mobile phone with 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.

IV. CONCLUSION

In this paper we have seen that due to increase in mobile users there has been tremendous improvement in cellular technology. We have given details for each of the generation in detail. At the end table shows the comparative study of the 5 generations of the wireless network evolution based on various features

REFERENCES

[1]. Awanish Kaushik and Anubhav Kumar, Wireless Communication and Network Systems (2009).

[2]. Frattasi, S. Fathi, H. Fitzek, F.H.P. Prasad, R. Katz,―Defining 4G technology from the users perspective‖ IEEE, Jan.-Feb. 2006, Volume: 20, Issue: 1, pp 35-41

[3]. X. P. Costa and H. Hartenstein. ―A Simulation Study on the Performance of Mobile IPv6 in a WLAN - based Cellular Network, Computer Networks‖, 40(1):191–204,September 2002.

[4]. 4G-Advanced wireless communication, Savo g. Glisic,2nd edt, john willy & sons ltd

[5]. www.India times.com

[6]. www.3g4gblogspot.com
[7]. www.4G.co.uk
[8]. www.4gwirelessevolution.tmcnet.com
[9]. "Prospective of Fifth Generation Mobile Communications" by Dr. Anwar M. Mousa of University of Palestine, Gaza- Palestine published in International Journal of Next-Generation Networks (IJNGN) Vol.4, No.3,September 2012
[10]. "5G Mobile Phone Technology" from www.pediain.com.
[11]. Toni Janevski, ― AAA System for PLMN-WLAN Internetworking‖, Journal of Communications and Networks (JCN), pp.192-206, Volume 7,Number 2, June 2005.
[12]. Janise McNair, ang Zhu, ―Vertical Handoffs in Fourth Generation Multinetwork Environments‖, IEEE Wireless Communications, June2004.
[13]. Toni Janevski, ―Traffic Analysis and Design of Wireless IP Networks‖, Artech House Inc., Boston,
[14]. USA, 400 p., May 2003.
[15]. [14]. Suk Yu Hui, Kai Hau Yeung, ―Challenges in the Migration to 4G Mobile Systems‖, IEEE Communications Magazine, December 2003.
[16]. [15]. Bria, F. Gessler, O. Queseth, R. Stridth, M.
[17].
[18]. Unbehaun, J.Wu, J.Zendler, ―4-th Generation Wireless Infrastructures: Scenarios and Research
[19]. Challenges‖, IEEE Personal Communications, Vol. 8,

1G	2G/2.5G	3G	4G	5G
Start/Deployment				
1970/1984	1980/1999	1990/2002	2000/2010	2015-2020
Data rates/Bandwidth				
2kbps	14.4-64 kbps	2Mbps	200 Mbps to 1 Gbps	1Gbps and higher
Standards				
MTS,AMTS,IMTS	2G:GSM, 2.5GPRS,2.75 EDGE	IMT-2000, 3.5 G-HSDPA,3.75 HSUPA	Single unified Standard LTE,LTE adv.Mobile WiMAX	Single unified,standard
Technology				
Analog cellular technology	Digital narrow band circuit data, packet data	Digital Broadband,packet data	Digital Broadband Packet All, Very high Throughput	Proposed: Unified IP and seamless combination of broadband, Local area networks, wide area networks, personal area networks, wirelessLAN
Throughput: 14.4 kbps	**Throughput:- 20-200 kbps**	**Throughput: 3G: 200KBPS**	**Throughput:- 100-300 Mbps**	
Service				
Mobile telephony (voice)	2G: Digital voice,SMS 2.5: Higher capacity Packetized	Integrated high Quality audio, video and Data	Dynamic information access , wearable Devices	Dynamic information aaccess , wearable devices with AI capabilities
WEB Standard				
------	www	www(IPv4)	www (IPv4)	Wwww (IPv6)
Switching				
Circuit	2G:Circuit, 2.5G: Circuit for Access network & air interface; packet for core Network	Packet except Circuit for air interface	All Packet	All Packet
Multiplexing				
FDMA	TDMA,CDMA	CDMA	CDMA	CDMA
Core network				

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PSTN	PSTN	Packet N/w	Internet	Internet
Handoff				
Horizontal only	Horizontal only	Horizontal & Vertical		
Features				
-make use of analog radio signals services and analaog voice services and no data services	Used Digital radio signals-voice encoded to Digital signals GSM: Supported Digital voice service,SMS messaging,improved voice clarity, Comparitively Secure GPRS: Supported MMS,internet Comm.	Fast data transfer rate, Improved Spectral efficiency, greater network capacity.Services: Enhanced audio video streaming,video conferencing support, Web browsing at higher speeds, IPTV Support	Converged data And voice over IP ,Entirely packet switched network, Higher bandwidth To provide multimedia services at lower cost (upto 100Mbps) Services Enhanced audio,video streaming,IP telephony,HD mobile TV	Simultaneous access to different wireless technologies,complete wireless communication (Wireless world wide web, WWWW)Services-Dynamicinformation access,Wearable deviceswith AI capabilities
Shortfalls				
Shortfalls Low capacity,Unreliable handoff Poor voice links,Less secure	Digital signals were reliant on location & proximity, required strong digital signals to help mobile Phones	Need to Accommodate higher network Capacity	Being deployed	Yet to be implemented