An Overview of 5G Technology and its Applications in Telecommunication Domain

Ritesh Saraswat[#1], Monika Bhati[#2] , Ankush Prajapat[#3]

[#1] *Associate Professor, JIET , Jodhpur,India*
ritesh_saraswat80@yahoo.com
[#2] *Sr. Assistant Professor, JIET, Jodhpur, India*
monika.bhati@jietjodhpur.com
[#3] *Assistant Professor, JIET , Jodhpur, India*
ankushprajapat@gmail.com

Abstract— **The search for new technology is always the main motive of the leading cell phone to innovate their competitors. 5G Technology stands for 5th Generation mobile technology and include all types of advanced features which makes 5G technology most powerful and in huge demand in near future. 5G technology will change the means to use cell phones within very high bandwidth of about 1Gbps or higher. With 5G pushed over a VoIP-enabled device, people will experience a level of call volume and data transmission never experienced before.5G technology will offer the services in pervasive networks, radio resource management, high altitude stratospheric platform station (HAPS) systems etc. The creation and entry of 5G technology into the mobile marketplace will launch a new revolution in the way international cellular plans are offered. A user can hook their 5G technology cell phone with their laptop to get broadband internet access. 5G technology has extraordinary data capabilities and has ability to tie together unrestricted call volumes and infinite data broadcast within latest mobile operating system. 5G Technologies have an extraordinary capability to support software and consultancy. The router and switch technology that is going to be used in 5G network will provide high connectivity. The 5G design is based on user-centric mobile environment with many wireless and mobile technologies on the ground. The 5G technology distributes internet access to nodes within the building and can be deployed with union of wired or wireless network connections. 5G technology has a bright future because it can handle best technologies and offer priceless handset to their customers. May be in coming days 5G technology takes over the world market.**

Keywords— **5G technology, bandwidth, , broadband, wireless network.**

I. INTRODUCTION

The present cell phones have it all. Today phones have everything ranging from the smallest size, largest phone memory, speed dialling, video player, audio player, and camera and so on. Truly innovative technology changing the way mobile phones will be used. With the emergence of cell phones, which are similar to a PDA, we can now have our whole office within the phone. Cell phones will give tough competitions to laptop manufacturers and normal computer designers. Even today there are phones with gigabytes of memory storage and the latest operating systems .Thus one can say that with the current trends, the industry has a real bright future if it can handle the best technologies and can produce affordable handsets for its customers. Thus we will get all our desires unleashed in the near future when these smart phones take over the market. 5G Network's router and switch technology delivers Last Yard Connectivity between the Internet access provider and building occupants. 5G's technology intelligently distributes Internet access to individual nodes within the building. The creation and entry of 5G technology into the mobile marketplace will launch a new revolution in the way international cellular plans are offered. [1]

II. EVOLUTION OF MOBILE TECHNOLOGIES

The below figure shows the Evolution of Mobile Technology:
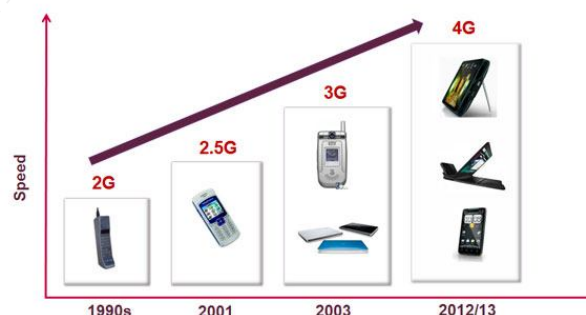
Figure: Evolution of Mobile Technology
Source: Website, consumers.ofcom.org.uk

Cell phones are used millions and billions of users worldwide. Past 20 years have viewed many inventions in several mobile communications subscribers and it looks that it will develop vastly in upcoming years. As with several technologies, advancement in wireless communication exists mainly through a steady evolution process. The 3G network is also developed gradually from basic mobile communication and each step of its evolution (1G, 2G) have played essential roles.

A. 1G: First generation mobile phones

The First Generation or 1G mobile networks were introduced in 1970s. These systems were known as cellular, which was further reduced by the term "cell", due to the process by which the signals were provided off between towers. The signals of cell phone were based on transmission of analog system and first generation appliances were less costly and heavy comparatively than former appliances. Some of the most familiar standards unfolded for First Generation systems were Total Access Communication Systems, Nordic Mobile Telephone and Advanced Mobile Phone Systems. The global market of mobile phone developed from 30 to 50% annually with the existence of first generation network, and many subscribers worldwide attained approximately 20 million by 1990[2].

B. 2G Wireless system

2G (or 2-G) is short for second-generation wireless telephone technology. Second generation 2G cellular telecom networks were commercially launched on the GSM standard in Finland by Radiolinja (now part of Elisa Oyj) in 1991. 2G network allows for much greater penetration intensity. 2G technologies enabled the various mobile phone networks to provide the services such as text messages, picture messages and MMS (multi media messages). 2G technology is more efficient. 2G technology holds sufficient security for both the sender and the receiver. All text messages are digitally encrypted. This digital encryption allows for the transfer of data in such a way that only the intended receiver can receive and read it.

Second generation technologies are either time division multiple access (TDMA) or code division multiple access (CDMA). TDMA allows for the division of signal into time slots. CDMA allocates each user a special code to communicate over a multiplex physical channel. Different TDMA technologies are GSM, PDC, iDEN, IS-136. CDMA technology is IS-95. GSM has its origin from the Group special Mobile, in Europe. GSM (Global system for mobile communication) is the most admired standard of all the mobile technologies. Although this technology originates from the Europe, but now it is used in more than 212 countries in the world. GSM technology was the first one to help establish international roaming. This enabled the mobile subscribers to use their mobile phone connections in many different countries of the world's is based on digital signals ,unlike 1G technologies which were used to transfer analogue signals. GSM has enabled the users to make use of the short message services (SMS) to any mobile network at any time. SMS is a cheap and easy way to send a message to anyone, other than the voice call or conference. This technology is beneficial to both the network operators and the ultimate users at the same time. [3]

In comparison to 1G's analog signals, 2G's digital signals are very reliant on location and proximity. If a 2G handset made a call far away from a cell tower, the digital signal may not be enough to reach it. While a call made from a 1G handset had generally poor quality than that of a 2G handset, it survived longer distances. This is due to the analog signal having a smooth curve compared to the digital signal, which had a jagged, angular curve. As conditions worsen, the quality of a call made from a 1G handset would gradually worsen, but a call made from a 2G handset would fail completely.[4]

C. Present 3G networks

The third Generation or 3G revolution permitted mobile phone customers to use video, graphics and audio applications. Over third generation it is applicable to view video telephony and view streaming videos although such tasks are constrained severely by bottlenecks of network and over-usage[7]. Third Generation or 3G phone speeds deliver up to 2 Mbps but renders only better conditions and in stationary mode. Moving at a high speed can reduce the bandwidth of 3G to a mere 145 Kbps. Schiller (2003) described that the cellular services of 3G also referred as Universal Mobile Telecommunication System, support greater rates of data and open the way to online style applications.3G technology supports both circuit and packet switched transmission of data and an individual set of standards can be used worldwide with capability over different mobile appliances. Universal Mobile Telecommunication System provides the availability of global roaming, with essential access to Internet from any place[8].

D. 4G Wireless system

4G refers to the fourth generation of cellular wireless standards. It is a successor to 3G and 2G families of standards. The nomenclature of the generations generally refers to a change in the fundamental nature of the service, non-backwards compatible transmission technology, and new frequency bands.3G technologies make use of TDMA and CDMA. 3G (Third Generation Technology) technologies make use of value added services like mobile television, GPS (global positioning system) and video conferencing. The basic feature of 3G Technology (Third Generation Technology) is fast data transfer rates[3].

High-Speed 4G Mobile Networks

Mishra, Ajay [5] described that the present mobile telephony generation i.e. Fourth Generation or 4G has been developed with the target of offering rates of transmission upto 20 Mbps while accommodating Quality of Service [QoS] features simultaneously [6].Quality of Service will permit users and their telephone carrier to organize traffic according to the kind of application using their bandwidth and adjust between their various requirements of telephone at a moment's notice.

E. The 5G technology

5G Technology stands for 5th Generation Mobile technology. 5G technology has changed the means to use cell phones

within very high bandwidth. User never experienced ever before such a high value technology. The 5G technologies include all type of advanced features which makes 5G technology most powerful and in huge demand in near future. The gigantic array of innovative technology being built into new cell phones is stunning. 5G technologies which are on hand held phone offering more power and features than at least 1000 lunar modules. A user can also hook their 5G technology cell phone with their Laptop to get broadband internet access. 5G technology including camera, MP3 recording, video player, large phone memory, dialling speed, audio player and much more we never imagine. For children rocking fun Bluetooth technology and Pico nets has become in market.[3]

What 5g technology offers?

5G technology is going to be a new mobile revolution in mobile market . Through 5G technology now we can use worldwide cellular phones and this technology also strike the china mobile market and a user being proficient to get access to Germany phone as a local phone. With the coming out of cell phone alike to PDA now our whole office in our finger tips or in our phone. 5G technology has extraordinary data capabilities and has ability to tie together unrestricted call volumes and infinite data broadcast within latest mobile operating system. 5G technology has a bright future because it can handle best technologies and offer priceless handset to their customers. May be in coming days 5G technology takes over the world market. 5G Technologies have an extraordinary capability to support Software and Consultancy. The Router and switch technology used in 5G network providing high connectivity. The 5G technology distributes internet access to nodes within the building and can be deployed with union of wired or wireless network connections. The current trend of 5G technology has a glowing future.[3]

III. COMPARISON OF 1G-5G TECHNOLOGY

The table below shows the comparison among the various technologies:

Technology / Features	1G	2G/2.5G	3G	4G	5G
Start/ Deployment	1970/ 1984	1980/ 1999	1990/ 2002	2000/ 2010	2010/ 2015
Data Bandwidth	2 kbps	14.4-64 kbps	2 Mbps	200 Mbps to 1 Gbps for low mobility	1 Gbps and higher
Standards	AMPS	2G: TDMA, CDMA, GSM 2.5G: GPRS, EDGE, 1xRTT	WCDMA, CDMA-2000	Single unified standard	Single unified standard
Technology	Analog cellular technology	Digital cellular technology	Broad bandwidth CDMA, IP technology	Unified IP and seamless combination of broadband, LAN/WAN/ PAN and WLAN	Unified IP and seamless combination of broadband, LAN/WAN/PAN /WLAN and wwww
Service	Mobile telephony (voice)	2G: Digital voice, short messaging 2.5G: Higher capacity packetized data	Integrated high quality audio, video and data	Dynamic information access, wearable devices	Dynamic information access, wearable devices with AI capabilities
Multiplexing	FDMA	TDMA, CDMA	CDMA	CDMA	CDMA
Switching	Circuit	2G: Circuit 2.5G: Circuit for access network & air interface; Packet for core network and data	Packet except circuit for air interface	All packet	All packet
Core Network	PSTN	PSTN	Packet network	Internet	Internet
Handoff	Horizontal	Horizontal	Horizontal	Horizontal and Vertical	Horizontal and Vertical

IV. 5G MOBILE NETWORK ARCHITECTURE

Fig. 1and Fig. 2 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. [1]. Routing of packets should be carried out in accordance with established policies of the user.
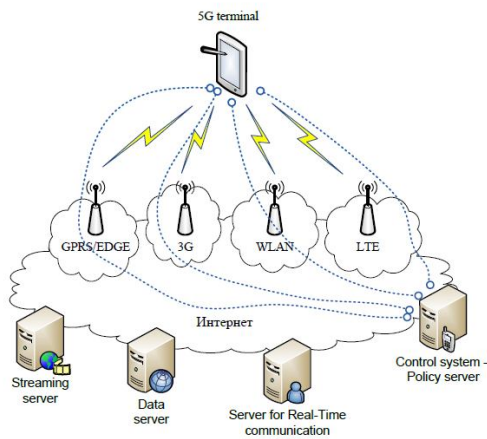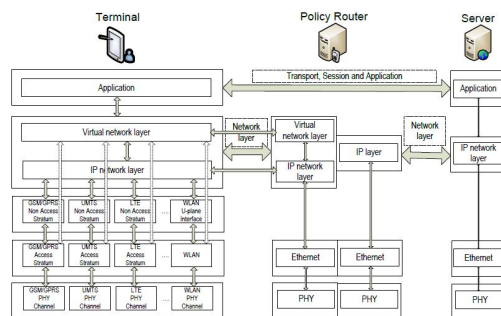
Fig. 1:Functional Architecture for 5G Mobile
Networks

Fig. 2:Protocol Layout for the Elements of the
Proposed Architecture

Application connections are realized between clients and servers in the Internet via sockets. Internet sockets are endpoints for data communication flows. Each socket of the web is a unified and unique combination of local IP address and appropriate local transport communications port, target IP address and target appropriate communication port, and type of transport protocol. Considering that, the establishment of communication from end to end between the client and server using the Internet protocol is necessary to raise the appropriate Internet socket uniquely determined by the application of the client and the server. This means that in case of interoperability between heterogeneous networks and for the vertical handover between the respective radio technologies, the local IP address and destination IP address should be fixed and unchanged. Fixing of these two parameters should ensure handover transparency to the Internet connection end-to-end, when there is a mobile user at least on one end of such connection. In order to preserve the proper layout of the packets and to reduce or prevent packets losses, routing to the target destination and vice versa should be uniquely and using the same path. Each radio access technology that is available to the user in achieving connectivity with the relevant radio access is presented with appropriate IP interface. Each IP interface in the terminal is characterized by its IP address and netmask and parameters associated with the routing of IP packets across the network. [1,10]

In regular inter-system handover the change of access technology (i.e., vertical handover) would mean changing the local IP address. Then, change of any of the parameters of the socket means and change of the socket, that is, closing the socket and opening a new one. This means, ending the connection and starting e new one. This approach is not-flexible, and it is based on today's Internet communication. In order to solve this deficiency we propose a new level that will take care of the abstraction levels of network access technologies to higher layers of the protocol stack. This layer is crucial in the new architecture. To enable the functions of the applied transparency and control or direct routing of packets through the most appropriate radio access technology, in the proposed architecture we introduce a control system in the functional architecture of the networks, which works in complete coordination with the user terminal and provides a network abstraction functions and routing of packets based on defined policies. At the same time this control system is an essential element through which it can determine the quality of service for each transmission technology. This is on the Internet side of the proposed architecture, and as such represents an ideal system to test the qualitative characteristics of the access technologies, as well as to obtain a realistic picture regarding the quality that can be expected from applications of the user towards a given server in Internet (or peer). Protocol setup of the new levels within the existing protocol stack, which form the proposed architecture, is presented in Figure Protocol Layout for the Elements of the Proposed Architecture). The network abstraction level would be provided by creating IP tunnels over IP interfaces obtained by connection to the terminal via the access technologies available to the terminal (i.e., mobile user). In fact, the tunnels would be established between the user terminal and control system named here as Policy Router, which performs routing based on given policies. [1,10]

In this way the client side will create an appropriate number of tunnels connected to the number of radio access technologies, and the client will only set a local IP address which will be formed with sockets Internet communication of client applications with Internet servers. The way IP packets are routed through tunnels, or choosing the right tunnel, would be served by policies whose rules will be exchanged via the virtual network layer protocol. This way we achieve the required abstraction of the network to the client applications at the mobile terminal. The process of establishing a tunnel to the Policy Router, for routing based on the policies, are carried out immediately after the establishment of IP connectivity across the radio access technology, and it is initiated from the mobile terminal Virtual Network-level Protocol. Establishing tunnel connections as well as maintaining them represents basic functionality of the virtual network level (or network level of abstraction).[1]

V. FEATURES OF 5G TECHNOLOGY

- ➢ 5G technology offer high resolution for crazy cell phone user and bi-directional large bandwidth shaping.
- ➢ The advanced billing interfaces of 5G technology makes it more attractive and effective.
- ➢ 5G technology also providing subscriber supervision tools for fast action.
- ➢ The high quality services of 5G technology based on Policy to avoid error.
- ➢ 5G technology is providing large broadcasting of data in Gigabit which supporting almost 65,000 connections.
- ➢ 5G technology offer transporter class gateway with unparalleled consistency.
- ➢ The traffic statistics by 5G technology makes it more accurate.
- ➢ Through remote management offered by 5G technology a user can get better and fast solution.
- ➢ The remote diagnostics also a great feature of 5G technology.
- ➢ The 5G technology is providing up to 25 Mbps connectivity speed.
- ➢ The 5G technology also support virtual private network.
- ➢ The new 5G technology will take all delivery service out of business prospect
- ➢ The uploading and downloading speed of 5G technology touching the peak .
- ➢ The 5G technology network offering enhanced and available connectivity just about the world [11].

VI. CHALLENGES AND REQUIREMENTS

The three fundamental requirements for building 5G wireless networks are:

1) Capabilities for supporting massive capacity and massive connectivity
2) Support for an increasingly diverse set of services, application and users –all with extremely diverging requirements for work and life
3) Flexible and efficient use of all available non-contiguous spectrum for wildly different network deployment scenarios

Mobile networks will increasingly become the primary means of network access for person-to-person and person-to-machine connectivity. These networks will need to match advances in fixed networking in terms of delivered quality of service, reliability and security. To do so, 5G technologies will need to be capable of delivering fiber-like 10 Gb/s speeds to make possible ultra-high definition visual communications and immersive multimedia interactions. These technologies will depend on ultra-wide bandwidth with sub-millisecond latencies [9,12].

VII. CONCLUSION

A new revolution of 5G technology is going to give tough completion to normal computer and laptops whose marketplace value will be effected. The new coming 5G technology is available in the market in affordable rates, high peak future and much reliability than its preceding technologies. This technology helps to promotes stronger links between people working in different fields creating future concepts of mobile communication, internet services , cloud computing , all pie network , and nanotechnology .

5G-A promising generation of wireless communication that will change people's lives.Wireless carriers have an opportunity to shorten investment return, improve operating efficiency and increase revenues. 5G can serve as a flexible platform. Migration to 5G networks ensures convergence of networks, technologies, applications and services.

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