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paper text:

An extensive review on generations of growth in Telecommunication S Swathi, Department of Computer Science and

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Amrita Vishwa Vidyapeetham (University), Ettimadai, Coimbatore—641112, Kv_shriram@cb.amrita.edu Abstract Internet has become an integral part of our daily life. Since 1830 people has been communicating with one another. Voice communication, the first form of communication, started in 1840's through wires. Around 1910's communication through air, wireless telephony came into existence, from which the pre-cellular communication came into use. Then onwards, every decade saw an evolution in wireless technology. With every new generation of network, consumer is looking forward for better Quality of Service and higher technology. This article is a comparison between the various generations of wireless network. It is essential for any human to have some basic knowledge about the technology he is using. In spite of many articles available this would help you better to know in detail about the various technologies behind our day- to-day communications. The advantages over the previous generations, the services offered, and the speed of connectivity are made clear in this article. The field of wireless communication is an ever expanding and always flourishing field. Research and development will always be looking forward for better generation with much advanced technology to provide better quality of service and also increase efficiency. So this article would also help you to understand the basics and the current situation and also develop an interest in the ever expanding field. Keywords-

1**First Generation, Second Generation, Third Generation, Fourth Generation,**

Fifth Generation, GPRS, EDGE, HSDPA, HSPA, LTE-A Introduction The fifth basic necessity of livelihood in today's world is internet. This article will help you understand the evolution of communication networks. This started with 0G in 1970's when efforts were taken to make communication possible between two places without physical connection. 0G, also known as pre-cellular technology, was focused on developing a powerful base station system that could send signals as far as possible to cover the large area. General conception of pre-cellular communication was to transmit a signal as far as possible whereas that of cellular phone was to limit the range of signal transmission. Each area would have a base station which is called a 'cell'; this way the same frequencies used in one cell could be used in different cells, so the frequencies can be reused for more substations. 0G/0.5G were mostly used in cars or trucks. The trunk contained the 'transceiver' and the 'head' was attached near to the driver's seat. Push to Talk (PTT), Mobile Telephone System (MTS), Improved Mobile Telephone Service (IMTS), and Advanced Mobile Telephone System (AMTS) are the technologies used in 0G [1]. From this, the technology has grown and a new generation of network is evolved every decade. In 1980, the first generation evolved replacing cellular phone. Since then the usage of mobile phones and mobile applications has increased to an extent where even kids own a mobile phone of their own. Consumers expect more facilities with every innovation

that is made in various generations, failing which that generation of communication becomes a failure model. Less traffic, higher data rates and high security are being the central goal for the further generations. It All Begins Here With 1g First Generation of wireless telecommunication was introduced in the early 1980s. Analog signals were the basis for the first generation of wireless networks. An Analog signal is defined as a continuous signal containing time varying quantities and constant fluctuations. Different countries used different 1G standard and they are: ‣ United States: Advanced Mobile Phone System (AMPS) ‣ Denmark, Finland, Norway and Sweden: Nordic Mobile Telephone (NMT) ‣ Italy: RTMI(Radio Telephone Mobile Integrato) ‣ United Kingdom: Total Access Communication System(TACS) ‣ West Germany, Portugal and South America : C-450 Circuit switched technology was the primary need of an analog system, and the first generation was designed only for voice and not data connection. 0G technology was taken over by 1G, which featured

1**Mobile Telephone System (MTS), Advanced Mobile Telephone System (AMTS),** and **Improved Mobile Telephone Service (IMTS)[**

1]. On using analog signals voice

1**gets modulated to a higher frequency and it is transmitted** to **radio towers using Frequency Division Multiple Access (FDMA). In**

FDMA, each individual is allocated one or more frequency bands as channels. But the quality of connection was a failure. Since there was play back of voice calls in radio towers, there was no security, 1G lacked in capacity and the voice links were poor. There were nearly 20 million subscribers for 1G phone and the annual growth rate was 30 to 50 percent. Navigation to 2G 2G refers to second generation of wireless telecommunication; it was introduced in the year 1990s. Digital signals were used in second generation as opposed to analog signals in first generation. An electrical signal that gets converted into patterns of bits, i.e. 0’s and 1’s is called a digital signal. Digital signal has a discrete value at each sampling point. The main difference between 1G and 2G is that 1G uses analog signals whereas its digital in 2G. 2G networks were launched on GSM (Global System Mobile communication) standard in Finland in 1991.

2**Depending on the type of multiplexing 2G technologies can be divided into Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA).**

Multiplexing is sending of multiple signals or streams of information simultaneously in the form of single or complex signal, which can be recovered at the receiving end as separate signals. The Second Gen was mainly based on: ? GSM (Global System Mobile communication) ? IS-95 also known as CDMAONE ? PDC (Personal Digital Cellular) ? IDEN Global System for Mobile communication (GSM) Base Station Subsystem (BSS) is the main element of GSM, which contains Base Transceiver Station (BTS) and Base Station Controller (BSC) and the Network Switching Subsystem (NSS) consists of Mobile Switching Centre (MSC), Visitor Location Register (VLR), Home Location Register (HLR), Authentication Centre (AC) and

Equipment Identity Register (EIR) [4]. This network provides the basic services like speed and data up to 9.6 Kbit/sec. Fixed Telephony networks are a part of GSM network. 2G networks were digitally encrypted; it allowed greater mobile phone penetration levels; text message (SMS), voice message and MMS (Multimedia Messages) were the services provided in second gen networks. All the text messages were digitally encrypted, such that only that particular receiver can read it. System capacity increases on using digital signals because: ? More voice calls can be transmitted in same bandwidth as digital signals can compress and multiplex voice data more efficiently than analog. ? Main aim of digital systems were to reduce emission of radio power, for doing so the cells had to be smaller, hence more cells were fitted in same space. Since the cost of cell tower and its equipment were less expensive, emission of radio power could be minimised. Though digital calls are static-free and have minimal background noises, the quality of signal is reduced i.e. range of sound transmitted is reduced. In less populous area, the weaker digital signal transmitted may not be sufficient to reach a cell tower. This particular problem prevails on higher frequencies of 2G system. Analog's smooth decay curve and digital's jagged pulse can be of both advantage and disadvantage. Digital is better on normal conditions, on worse conditions it has occasional dropouts and at times it may fail completely. Fail meaning call gets dropped, behaves unintelligibly whereas analog fails gradually meaning they hold a call for a longer duration and at least some audio transmitted is understood. Some stable growth towards 2.5G 2.5G is an intermediate step between 2G and 3G networks. GPRS (General Packet Radio Service) is technology used by GSM operators, which is an additional feature of 2G and also some facilities of 3G are available in 2.5G General Packet Radio Service (GPRS)

1 **New elements such as SGSN (serving GPRS) and GGSN (Gateway GPRS) were added to the existing GSM system**

due to increased air interface communication, which enabled the transmission of packet data on air interface, thus is called as 'Packet Core Network'. Apart from SGSN and GGSN,

1 **IP routers, firewall servers and Domain Name Servers**

(DNS) are also a part of GPRS, enabling wireless access to the internet with a speed of 150 kbps in optimum conditions [1]. 2.5G to 2.75G – A little growth 2.75G is referred as EDGE (Enhanced Data Rates for Global Evolution), which is faster than GPRS, but slower than 3G networks. More sophisticated codes were used, and the data rates were increased up to 384kbps. The existing GSM carriers can upgrade their GSM/GPRS networks in to EDGE/EGPRS as bolt-on enhancement. EDGE can function with GPRS deployed networks, provided the necessary upgrades were made by the carrier. Bandwidth of EDGE is up to 236kbit/s with 4 timeslot in packet mode, meaning four times the traffic of standard GPRS can be handled [3]. Table 1 shows the comparison between 2G, 2.5G and 2.75G. Here you go, the most wanted 3G 3G is an outcome of research carried out by International Telecommunication Union (ITU). The main disadvantage of 2G was its in-ability to provide higher data access. With the increasing use of mobile phones the demands for increasing connection was required. With the evolution of 3G this was possible. More coverage and minimal investment growth is the objective of 3G. The first 3G network was first introduced in 1998. The technical specifications required for a network to be called 3G were released as 'IMT-2000', and 400 MHz to 3 GHz was the communication spectrum allotment for 3G.[2] This period saw an increased development in usage of smartphones (phone which uses operating system), the abilities of

a PDA combined with a mobile phone, facilitated a need for mobile internet connectivity. Internet browsing can now be done using 'Mobile Broadband', due to the speed and capability of 3G networks. Connecting to internet using USB modems have become very common these days. With the evolution of 3G came HSPA-High Speed Packet Access. Wireless voice telephony, video calling and data transmissions became possible with 3G. With the introduction of HSPA the downlink speed of data was 14.4Mbps and that of uplink was 5.8Mbps as compared to 14.4 Kbps of 2G. Spectrum

7**refers to the amount of information that can be transmitted over a given bandwidth.** The standards used **in**

3G are Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA). Improved 3G as 3.5G 3.5G's main usage was High Speed Downlink Packet Access (HSDPA). It offered relatively more speed as compared to 3G with speed up to 5MHz on downlink. Implementation of 3.5G

5**includes Adaptive Modulation and Coding (AMC), Multiple-Input Multiple-output (MIMO), Hybrid Automatic Request (HARQ), fast cell search and advanced receiver design. 3.**

5G shaped as 3.75G 3.75G aims on High Speed Uplink Packet Access (HSUPA). It improves the existing 3G communication using the WCDMA protocol. The improved 3GPP, Evolved HSPA (HSPA+) was released late in 2008, which was adopted in 2010. The first HSPA supported peak data rates of up to 14 Mbps and 5.76 Mbps on the downlink and uplink respectively. The latest UMTS release, HSPA+, can provide peak data rates up to 56 Mbps (28 Mbit/s in existing services) and 22 Mbps in downlink and uplink respectively. The standards used by the cell phones are CDMA2000 and IS-95 hybrids. HSPA reduced latency and provided more system capacity as much as five times for downlink and twice in the uplink as compared to the original WCDMA protocol.

2**HSUPA will enhance advanced** one **-to-** one **data applications with higher and symmetric data rates, like mobile e-mail and real-time** interactive **gaming.**

The comparison between 3G 3.5G and 3.75G is shown in Table.2 The Future, 4G - A Step Ahead From 3G The 4G technology is the successor of the 3G technology. The growing demand of higher bit rates is the major reason in the deployment of 4G. 3G was allocated bandwidth in 2.4GHz which would get saturated with increasing users. And 3G is more expensive because it requires base stations very close to each other and it consumes more power. Roaming and data/voice work together has not been implemented. The main problems with circuit switched telephony are network traffic, poor Quality of Service, and more time-lag in transfer of data. The detailed comparison between 2G 3G and 4G is given in Table 3. For a network to be called 4G, there are a set of requirements which needs to be satisfied and these requirements were specified by International telecommunication Union-Radio communication (ITU-R) sector in 2008 and these requirements were termed as International Mobile Telecommunications Advanced(IMT-A). The requirements were: ? IP packet switched network. ? Data rates of 100Mbps for high mobility communication, 1Gbps for low mobility communication. ? Dynamical sharing and usage of

network resources to allow multiple users per cell simultaneously. ? Bandwidth of 5-20 MHz, optionally up to 40MHz. ? Spectrum of 15bit/s/Hz on downlink, and 6.75bit/s/Hz on uplink. For bandwidth less than 67MHz downlink spectrum should be 1Gbps. ? System Spectral Efficiency must be, 3bit/s/Hz/cell in downlink and 2.25 bit/s/Hz/cell in uplink. ? Over heterogeneous networks, there should be smooth handover of signals. ? Offer high quality service for next gen multimedia. Basically all 4G technology proposals were based on only two technologies- • Long Term Evolution Advanced (LTE-A) standardized by 3rd Generation Partnership Project (3GPP) •802.16m standardized by the Institute of Electrical and Electronic engineers (IEEE) i.e. WiMAX. LTE-A is necessarily an enhancement of LTE. LTE has bit rates of 100MBit/s downlink and 50MBit/s uplink if 20MHz channel is used and will increase on usage of array of antenna for Multiple-Input Multiple-Output (MIMO) networks. LTEA has additional spectrums and multiplexing along with Coordinate Multi-point Transmission for higher data speeds. Few networks were considered as predecessor of 4G as they met a particular requirement stated by IMT-A. Two of those networks are Flash-OFDM and iBurst or High Capacity Spatial Division Multiple Access (HC-SDMA). 4G works on Internet protocol packet-switched telephony. Data must pass through the seven Open System Interconnection (OSI) layers to get converted into packets. The first three layers are called Media Layers and the rest four layers are called Host Layers. The

> 8**layers are: Physical Layer, Data Link Layer, Network Layer, Transport Layer, Session Layer, Presentation Layer, Application Layer**

respectively. At transmitter end Application layer breaks the application into network process. Presentation layer converts the data into machine readable form. Session layer mainly takes care of setting up the session and time for communication and transfer of data. Transport layer segments the data and links it with the network. The network layer creates packets of varying size and also assigns destination and home IP to the packets. Data link Layer assigns destination and host MAC address to the packets. Thus the packets are ready and are let into the Physical layer which is the physical connections of the network. At receiver end the packet gets into the

> 8**Physical layer. The Data link layer** checks whether **the** MAC address in **the** packet matches **the**

device MAC address. Network layer checks whether the IP address in the packet is the devise IP. Transport layer assembles the collected packet and sends it to the Presentation layer. The number of packets to be collected depends on the Session layer. The Presentation Layer converts the machine based language into user understandable form. The application layer combines the network process into application. 4G is all-IP technology. Despite preceding generations in 4G even voice is converted into packets and transferred through IP. Voice over IP (VoIP) is used to convert voice into data packets and send it through IPs. It encodes voice, audio and video by audio codecs, which are just an encoder and decoder of audio and datagrams. By streaming media, video codecs are sent as digital signal. At the receiving end these codecs decode the audio. Packet-Switched telephony avoids the tolls of traditional Public Switched Telephone Network (PSTN). Circuit switching has constant bit rate and constant delay during communication. It has limited connections which are exclusive during any communication. The main advantage of packet- switched telephony over PSTN is that it is more reliable and comparably less expensive. This PSTN helps in achieving data transmission with comparatively minimal time lag, thus

enhances the data rates. Packet-switched telephony coverts all voice and data into blocks of grouped data called packets, irrespective of the content, type or size by passing through the OSI layers. Another major advantage is if a packet is damaged the entire packet need not be resend, the damaged part alone is resend. The packet may use any number of paths based on availability and network to reach a single destination. 4G uses Multiple-Input Multiple-Output (MIMO) connection for ultra-high spectral efficiency. Efficiency of MIMO is increased by multi-antenna and multi-user MIMO (spatial processing). MIMO is of three

3**categories – precoding, Spatial Multiplexing(SM), and diversity coding.**

These categories may also be combined with one another based on knowledge and network necessity. Precoding The signal power is maximized by emitting signals from appropriate antenna with appropriate phase and weight gain. This process is termed as beamforming. Beamforming add up signals from different antenna constructively and reduces multipath fading effect. Precoding is basically multi-stream beamforming.

6**Spatial Multiplexing Spatial Multiplexing** is achieved by **MIMO antenna configuration. In** this type of **multiplexing, a high rate signal is split into multiple lower-rate streams and** these streams are **transmitted from different antenna** at **same frequency channel. These**

streams can be separated into parallel channels, if at the receiver end there is accurate Channel State Information (CSI). Thus, during high signal-to-noise ratio the channel-capacity increases. Number of streams depends on

3**the number of antennas at the transmitter or receiver.**

At the receiver end, to allow good separability of streams, the receivers should be scheduled

3**with different spatial signatures. Diversity Coding** This is **used when**

the transmitter has no knowledge about the channel.

3**The signal coded using space- time coding is**

transmitted as a single stream. Multiple, redundant copies of data streams are sent to the receiver so that at least some data survives. It exploits

3**independent fading in multiple antenna links** and thus enhances **signal**

diversity.

An interesting feature of 4G is Frequency –domain-equalization. It uses multi-carrier modulation through

7**Orthogonal Frequency-Division Multiplexing (OFDM)** in **downlink and Single-Carrier Frequency-Domain-** Equalization **(SC-** FDE) in **uplink.**

Multiplexing generally means transmitting multiple data streams simultaneously across a single physical channel. FDM dynamically allocates each channel to a unique frequency range. This unique frequencies (a combination of Frequency and Time Domain) and bandwidth are allocated such that they do not overlap to prevent loss of data. It is a combination of Frequency domain and Time domain multiple access. It is more scalable and the channel frequency is also selective. Another advantage of the multiplexing access technique is they involve very less complexity for equalization at the receiver. 4G uses many algorithms and coding for better Quality of service. It uses Turbo code to minimize the Sound-to-Noise (SNR) ratio at receiver end. Also it uses Adaptive Modulation and Coding (AMC), generally known as link adaption. The main purpose of link adaption is to improve the rate of transmission and error-correction in bit rates. Mobile IP is used for making communication while moving from one place to another, especially between different networks. The mobile IP has a Home Agent (HA) which stores user's home address details and a Foreign Agent (FA) which is responsible for information regarding the host of mobile nodes. HA acts as a router in host's home network which tunnels datagrams while the FA acts as a router in the host's visiting network. The Mobile Nodes (MN) is responsible for discovering whether the host is in home network or foreign network. Another interesting feature of 4G is that the home nodes are connected to fixed internet broadband infrastructure. This is known as IP based femtocells, a small low power cellular base station used at homes or small business. It provides more network connectivity and coverage and prevents loss of signal. 4G is supported by Internet Protocol version 6 (IPv6). In IPv6, the IP address availability numbers are increased in order to support large number of wireless devices. Network Address Translation (NAT) – sharing of limited available IP address among a large group, is also not needed anymore. 5G -The Scope of Betterment, An analysis 5G will be the successor of 4G and as historical records tells there is a new network generation evolved in every decade. According to the predictions 5G will be introduced by 2020. Lots of research is going on around the world to find the next advanced generation. Definitely it will be better than 4G in all standards. 5G is mainly worked upon with three goals: i) Cost-efficient network ii) High speed mobile network iii) Fiber- wireless network Although 4G is an efficient network it is a little expensive. So 5G is being designed with a goal to achieve very high efficiency at a comparatively lower cost. For every new generation user will expect higher rates than the previous generation so 5G is worked upon to achieve bit rates at gigabytes per second even while on mobility. The wireless internet access is also planned for the first time. 5G is mainly based on the concept of Device-to-Device communication instead of a central server based connection. This is generally known as peer-to-peer communication. In the previous generations data signals were transmitted between two devices through a base station. Device-to- Device communication is the process of direct communication between any two devices without the control of base station. This connection link does not have the need to control the interference of various channels, which is one of the biggest challenges of the radio system. This is a major technology component of LTE-A. This will increase the spectral efficiency. It also reuses the spectrum and cellular resources to increase the system performance. 5G is also based on automated machine-to-machine intelligence. Machine to machine communication is transfer and exchange of data between any two machines through a network involving many tools. It is an integral part of internet of

things. Automated machine-to-machine communication eases the flow and exchange of data and increases the efficiency of communication and also decreases the cost of service. It enables various mechanisms including wired or wireless tools, sensors, devices, servers, robots space crafts and grid systems to communicate and exchange data. Research is going on to use millimeter wave bands (20-60 Hz) for the first time in history. They allow very broad bandwidths to access and supports speeds up to 10gigabyte per second. It will be transmitted through Fiber-Optic cables and thus achieving wireless internet access. It will be a short range service like Wi-Fi acting as a Wireless Local Area Network (WLAN). This wireless network does not has any router or physical access points for data flow and hence it is known as Dynamic Ad hoc Wireless Network (DAWN) along with smart antenna will make modulation more flexible. This uses a technique called flooding to forward data where each the nodes themselves acts as routers. The data is collected in a node and then it forwards to the next node in the network. The determination of node which it should be forwarded is dynamically done. A project is being conducted in developing 5G green dense small cells. It is massive distribution of the MIMO system in the previous Generation. Here the transmission point is equipped with many large antennas. This serves multiple users to communicate between different terminals simultaneously in the same time and frequency without any interference. Virtualization would also be extended to wireless 5G networks. It separates network infrastructure from the services. Thus it aids by allowing two different services to co-exist in a same infrastructure. This reduces the capital and operation expenses along with the number of core networks thus increase the feasibility of network. It provides some specific services and it will attract many consumers. Cognitive radio technology is also involved in 5G. In Cognitive technology, different radio technologies share the same unused spectrum efficiently; also the transmission scheme is dynamically adapted depending on the requirements of the technologies sharing it. Also there is work going on to impose Wi-Fi over light waves. It is known as Li-Fi .It uses light emitting diode to transfer data along light waves rather than radio waves. This is visible light communication network. 5G would be acting upon all things of day-to-day life besides mobile phones and computers. Its main concept is to develop multi path concurrent data paths. 5G would support IPv6 to add location and a network id to the address assigned. It interacts with devices with Artificial Intelligence (AI) along with mobiles and computers and this lays the path to augmented reality like Optical Head Mounted Displays. It would be a centralized network with no zone and access limit issues. The wireless web based applications include full media capabilities beyond 4G speeds. Thus we as consumers are looking forward to a bigger, better and a smarter network for the future, which will soon become an integrated part of our lifestyle. The following figure 1, has depicted the significant growth that the Telecom field has faced over years. Fig. 1 1G to 5G. TABLE 1: Comparison between 2G, 2.5G, 2.75G 2G 2.5G 2.75G YEAR OF RELEASE 1991 1997 1998 BANDWIDTH 14.4 kbps 384 kbps 473 kbps

5MULTIPLEXING TDMA,CDMA TDMA, CDMA TDMA, CDMA SWITCHING Circuit

Circuit Circuit SERVICES SMS, conference call, voice mail, caller id MMS, web browsing, supports for short audio and video clips. Better performance of 2.5G TABLE 2: Comparison between 3G, 3.5G, 3.75G 3G 3.5G 3.75G SPEED 2Mbps/down, 768Kbps/up 14.4Mbps/down, 3Mbps/Up 337Mbps BANDWIDTH 2MHz 14MHz 14MHZ SERVICE audio, video and data are of integrated high quality Voice and video telephony, mobile and fixed broadband HD video streaming, multimedia services like mobile TV MULTIPLEXING CDMA W-CDMA W-CDMA SWITCHING Packet(except air interface) Packet Packet YEAR OF DEPLOYMENT 2001 2007 2008 TABLE 3: Comparison between 2G, 3G, 4G Criteria 2G 2.5G 3G 4G Services offered ->Digital Voice Service ->PTT ->SMS ->Conference Call ->Caller ID ->Voice Mail 2G

services and : ->increased data speed -> Web browsing ->MMS 2.5G services along with: ->Full motion video ->Streaming music ->3D gaming ->Fast web Browsing Video and multimedia services with more higher rates in mobility and much more in static communication, better Quality of service, person-to-person video calling without time lag. Standard GSM GPRS,EDGE WCDMA, CDMA2000 Single Standard Bandwidth 14.4kbps 384kbps 2Mbps 200Mbps Year of release 1991 1999 2002 2009 Advantages *requires very low battery power *more voice clarity *lower power emissions *improved privacy *fast installation *less susceptible to disruption *More bandwidth, Security and reliability *supports 5 major radio technologies *rich multi- media services Higher data rates, better quality of service, efficient spectral usage, reduced network traffic, increased online privacy and security, reduced latency in communication Limitations *weaker signals may lead to loss of information, because it does not have enough power to reach the cell tower. *digital signal will have occasional signal dropouts or fail completely *reduced range of sound * *expensive *lower data rates *security is not highly reliable *wireless signals are easy to intercept *cost of upgrading the base station is high *higher power consuming and expensive *base stations needs to be in a closer proximity The hardware requirement is little expensive making most of the equipment out of date, Switching Circuit Circuit Packet except Circuit for air interface All packet Multiplexing TDMA,CDMA TDMA,CDMA CDMA CDMA Future scope More bandwidth can be allocated and usage of internet can be made possible Can be made more secure and provide higher data rates The dependency on base stations and high consumption of power can be reduced After the next generations come it would be used for much of WLAN and for private networks. Conclusion Our way of communication begun with pigeons, then moved on to messengers, then came pagers, walkie-talkie, and then the introduction of networks be it pre-cellular technology, first generation or second generation or the future fifth generation. With each generation we saw an additional facility being provided to the general public. Be it SMS in 2G, or voice conferencing in 2.5G or 3D gaming in 3G or video chatting in 4G, every generation had something new to provide us. As the customer’s demands for better quality and service of facilities grew, new technologies had to be worked out in order to meet the demands. But they weren’t satisfied with what was offered; it was an everlasting list to fulfil. Thus we can’t say the fifth generation is the final of the telecommunication networks, with every break-through in innovations we get a new generation. Therefore there is not stop to the number of generations of network as long as there demands, there will be fulfilments. References [1] Sapna Shukla, et.al.”Comparative Study of 1G 2G 3G and 4G”, JEC&AS, Vol. 2, No. 4, pp 55-62, April 2013, Online edition. Available: http://borjournals.com/Research_papers/Ap_2013/1248IT.pdf [2] C.S.Patil, et.al.”Development of Mobile Technology: a Survey”, IJAREEIE, Vol. 1, Issue 5, pp 374-378, November 2012. Online edition, Available: http://www.ijareeie.com/upload/november/6_Development of Mobile.pdf [3] Edge. [Online]. Available: http://www.3g.co.za/index.php/30-technology?start=16 [4] http://www.slideshare.net/shirazthegreat/fundamentals-of-cellular-network-planning-and- optimization [5] http://www.scipublish.com/journals/STOWC/papers/download/3305388.pdf