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# Evolution & Envisage of Mobile Network

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**Abstract:** In mobile network communication there is an endless quest for development of high bandwidth and high quality network. In this paper we will present the study of ongoing Generations of mobile communication network which are being used i.e. 1G, 2G, 3G and also try to find the evolution of new generation of mobile network. Current research in mobile wireless technology concentrates on advance implementation of 4G technology. Currently 5G term is not officially used. In 5G researches are being made on development of World Wide Wireless Web (WWWW), Dynamic Adhoc Wireless Networks (DAWN) and Real Wireless World. The Aim of this study is to show advancement in the field of new generations of mobile network and the emerging issue in 3G network which can be fulfilled in advance mobile network line up.

**Keywords:** DAWN, 5G, 4G, 1G, 2G, 3G & WWWW.

## I. INTRODUCTION

Communication is the physical transfer of data (a digital bit stream) over point-to-point or point-to-multipoint communication channel. Examples of such channels are copper wires, optical fibres, wireless communication channels, and storage media. We will deal with only wireless mobile network communication channel in this study. In the near future, however, broadband data access at high transmission rates will be needed to provide users packet-based connectivity to a plethora of services. It is also almost certain that the future wireless systems will consist of complementary systems with a set of different standards and technologies along with different requirements and complementary capabilities that will offer users ubiquitous wireless connectivity between mobile and desktop computers, machines, game systems, cellular phones, consumer electronic products, and other hand-held devices.

A key requirement in future wireless system is their ability to provide broadband connectivity with end-to-end Quality of Service (QoS), a high network capacity, and throughput at a low cost. Mobile network communication is continuously one of the popular areas that are developing at a thriving speed, with advanced techniques emerging in all the fields of mobile and wireless communications. In the past few decades, the mobile wireless technologies have experience of various generations of technology revolution & evolution, namely from 0G to 4G. Each generation have some standards, capacities, techniques and new features which differentiate it from previous generations.

### A. Fundamental Techniques

In this section we should understand some basic concepts or terms which are being used in explaining different technologies. As a name suggest, Mobile radio terminal means any radio terminal that can be movable during its operation. Depending on the radio channel, there can be three different types of mobile communication.

- Mobile system (MS)
- Base station (BS)
- Mobile Switching Center (MSC) or Mobile Telephone Switching office(MTSO)

A Mobile Station (MS) communicates to a fixed Base Station (BS) which in turn communicates to the desired user at the other end. The MS consists of transceiver, control circuitry, duplexer and an antenna while the BS consists of transceiver and channel multiplexer along with antennas mounted on the tower. The BS is also linked to a power source for the transmission of the radio signals for communication and is connected to a fixed backbone network. Figure 1 shows a basic mobile communication with low power transmitters/receivers at the BS, the MS and MSC. The radio signals emitted by the BS decay as the signals travel away from it. A minimum amount of signal strength is needed in order to be detected by the mobile stations or mobile sets. The region over which the signal strength lies above such a threshold value is known as the Coverage area of a BS.

**B. Radio Transmission Techniques**

Based on the type of channels being utilized, mobile radio transmission systems may be classified as the following three categories which is also shown in Fig.1.

**1. Simplex System:** In this system, simplex channels are used i.e., the communication is unidirectional. The first user can communicate with the second user. However, the second user cannot communicate with the first user. One example of such a system is radio broadcasting.

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**2. Half Duplex System:** Half duplex radio systems uses half duplex radio channels which allow for non-simultaneous bidirectional communication. The first user can communicate with the second user but the second user can communicate to the first user only after the first user has finished his conversation. At a time, the user can only transmit or receive information. A walkie-talkie is an example of a half duplex system which uses `push to talk' and `release to listen' type of switches.

**3. Full Duplex System:** Full duplex systems allow two way simultaneous communications. Both the users can communicate to each other simultaneously. This can be done by providing two simultaneous but separate channels to both the users. This is possible by one of the two following methods.

**i. Frequency Division Duplexing (FDD):** It supports two-way radio communication by using two distinct radio channels. One frequency channel is transmitted down-stream from the BS to the MS (Forward Channel). A second frequency is used in the upstream direction and supports transmission from the MS to the BS (reverse channel). Because of the pairing of frequencies, simultaneous transmission in both directions is possible. To mitigate self-interference between upstream and Down-stream transmissions, a minimum amount of frequency separation must be maintained between the frequency pair.

**ii. Time Division Duplexing (TDD)-** It uses a single frequency band to transmit signals in both the directions. It operates by toggling transmission directions over a time interval. This toggling take place very rapidly and is imperceptible to the user.

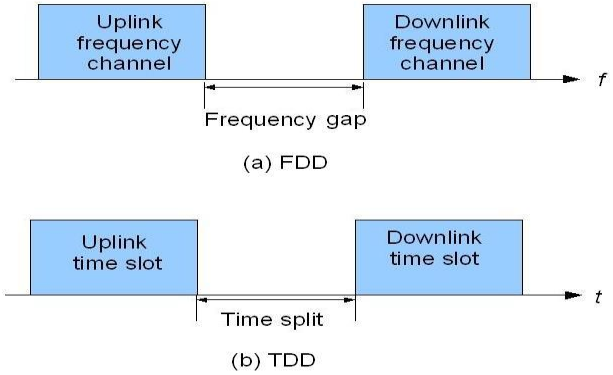


**Figure1. (a) Frequency division duplexing, (b) Time division duplexing.**

## II. ZERO GENERATION OR MOBILE RADIO TELEPHONE SYSTEM

**A. Zero Generation (0G)**

In 1946, the first car-based telephone was set up in St. Louis in the USA. In this setup the Radio transmitter is placed on top of the building. A single channel was used, and therefore a button was pushed to talk, and released to listen. This half duplex system is still used by modern day CB-radio systems used by police and taxi operators. In the 1960's the system was improved to a two-channel system, called IMPROVED MOBILE TELEPHONE SYSTEM (IMTS). This system didn't support Multiuser because frequency was limited. Later on this problem was solved by the idea of using cells to facilitate the re-use of frequencies. Multi users can be supported in such a cellular radio system. It was implemented for the first time in the advanced mobile phone system (AMPS). An AMP was and still is an analogue system, and is part of first generation cellular radio systems. Second generation systems are digital. In the USA two standards are used for second generation systems IS-95 (CDMA) and IS-136 (D-AMPS). Europe consolidated on one system called global system for mobile communications (GSM). Japan uses a system called personal digital cellular (PDC).

Cellular networks are called such because of the fact that a geographical area is divided up into cells, each cell being serviced by one or more radio transceivers (transmitter/receiver). Communication in a cellular network is full Duplex. Full duplex communication is attained by sending and receiving messages on two different frequencies frequency division duplexing (FDD). The reason for the cellular topology of the network is to enable frequency reuse. Cells a certain distance apart can reuse the same frequencies. This ensures the efficient usage of limited radio resources. Due to these new features, the number of mobile phone subscribers is increasing day by day.

**B. Zero generation (0.5G)**

**0.5G** was the advance version of 0G (Zero Generation or Mobile Radio Telephone system). This 0.5G technology had introduced ARP(Autoradiopuhelin) as the first commercial public mobile phone network. This ARP network was launched in 1971 at Finland. ARP was operated on 8 Channels with a frequency of 150 MHz (147.9 – 154.875 MHz band) and its transmission power was in a range of 1 to 5 watts. ARP used half duplex system for transmission (voice signals can either be transmitted or received at a time) with manual switched system. This Network contains cells (Land area was divided into small sectors, each sector is known as cell, a cell is covered by a radio network with one transceiver) with the cell size of 30 km. As ARP did not support the handover, calls would get disconnected while moving from one cell to another. ARP provided 100% coverage which attracted many users towards it. ARP was successful and became very popular until the network became congested. The ARP mobile terminals were too large to be fixed in cars and were expensive too. These

limitations led to invent of Autotel**.** Autotel are also known as PALM (Public Automated Land Mobile)**.** Autotel is a radio telephone service which in terms of technology lies between MTS and

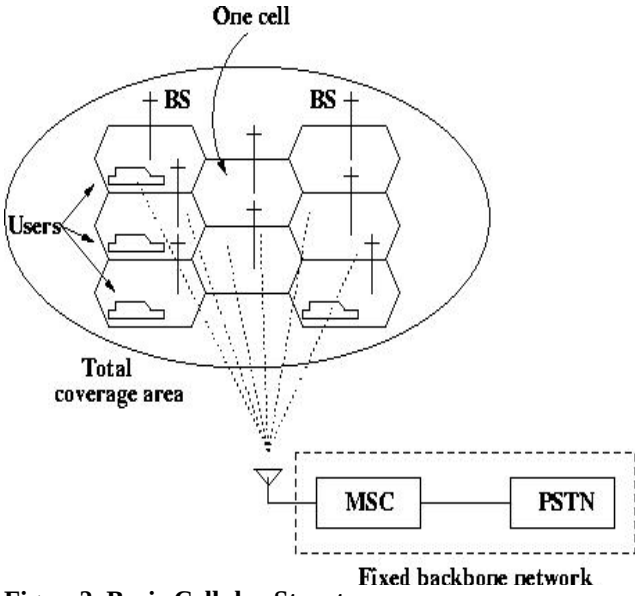


**Figure2. Basic Cellular Structure.**

IMTS. It used digital signals for messages like call step up, channel assignment, ringing, etc only voice channel was analog. This system used existent high-power VHF channels instead of cellular system. It was developed in Canada and Columbia. The first mobile phone system in the market was AMPS. It was the first U.S. cellular telephone system, deployed in Chicago in 1983 with coverage area of 2100 square miles. The 1G first generation

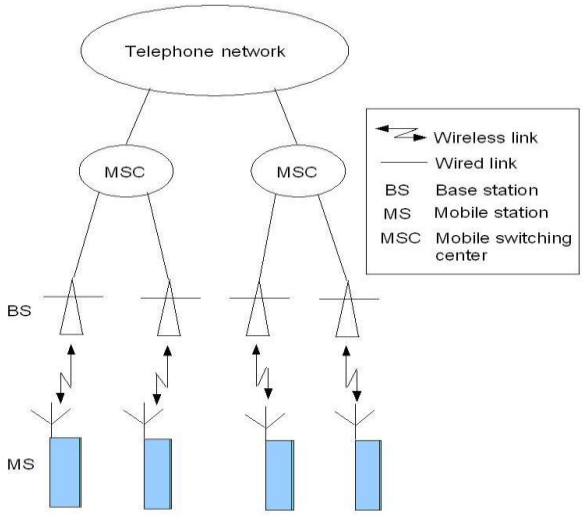


**Figure3. Basic mobile communication structure.**

mobile wireless communication system was analog system, which was based on a technology known as Advance Mobile Phone Service (AMPS). The main technology of this first generation mobile system was FDMA/FDD and analog FM.1G networks were conceived and designed purely for voice calls with almost no consideration of data services. This analog system was based on the technique known as Advanced mobile Phone Service (AMPS).This system was using frequency division multiple access (FDMA) with channel capacity of 30 KHz and frequency band of 824-894 MHz for Frequency Modulation Radio system. In 1979, the first cellular system in the world was introduced by Nippon Telephone and Telegraph (NTT) in Tokyo, Japan. After Two Years the cellular epoch reached Europe. The two most popular analogue systems were Nordic Mobile Telephones (NMT) and Total Access Communication Systems (TACS). Other than these, some other analog systems were also introduced in 1980s across the Europe. These all systems offered handover and roaming capabilities but the cellular networks were unable to interoperate between countries. This was one of the inevitable disadvantages of first-generation mobile networks.

**Table 1: Features of 1st Generation**

| Generations | 1G |
|---|---|
| Starts from | 1970-84 |
| Frequency | 800-900 MHZ |
| Data capacity | 2KBPS |
| Technology | Analog wireless |
| Standard | AMPS |
| Multiplexing | FDMA |
| switching | Circuit |
| Service | Voice only |
| Main network | PSTN |
| Hand off | Horizontal |

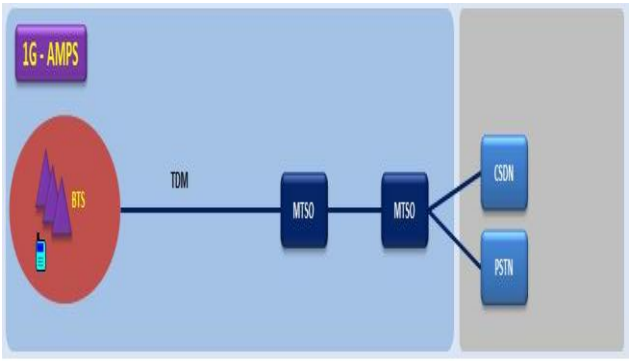


**Figure4. 1G AMPS Mobile Network Diagram**

## III. 2G SECOND GENERATION NETWORKS

2G first introduced in 1992, is the second-generation of cellular telephone technology and the first to use digital encryption of information. 2G networks were the first to offer data services and SMS text messaging, but their data transfer rates are lower than those of their successors. Digital modulation was introduced in 2G with the main technology as TDMA/FDD and CDMA/FDD. The 2G systems introduced three popular TDMA standards and one popular CDMA standard in the market. These are as follows:

### A. TDMA/FDD Standard

**1. Global System for Mobile (GSM):** The GSM standard, introduced by Groupe Special Mobile, was aimed at designing a uniform pan-European mobile system. GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1800 MHz frequency band.

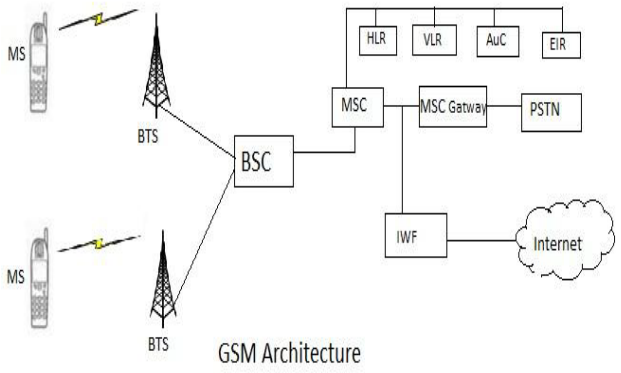


**Figure5. GSM Architecture**

**2. Interim Standard 136 (IS-136):** This system was famous by the name North American Digital Cellular (NADC). In this system, there were 3 full-rate TDMA users over each 30 KHz channel. The need of this system was mainly to increase the capacity over the earlier analog (AMPS) system.

**3. Pacific Digital Cellular (PDC):** This was developed as the counterpart of NADC in Japan. The main advantage of this standard was its low transmission bit rate which led to its better spectrum utilization.

### B. CDMA/FDD Standard

**1.Interim Standard 95 (IS-95):** Interim Standard95 (IS-95) is a second generation (2G) mobile telecommunication standard based on code division multiple access (CDMA) technology, which guarantees multiple access when sending voice and data between mobile phones and cell sites. IS-95 operates in the 800 MHz and 1900 MHz frequency bands. IS-95 is also known as TIA/EIA-95. It is marketed under the brand name CDMA One (cdma One). Certain services that have been standardized as a part of IS-95 standard are: short messaging service, slotted paging, over-the-air activation (meaning the mobile can be activated by the service provider without any third party intervention), enhanced mobile station identities etc.

## 2. 2.5G MOBILE NETWORKS

2.5G is the intermediate step in mobile communications, between second (2G) and third (3G) generation networks. It provides some of the benefits of 3G and can use some of the existing 2G infrastructure in GSM and CDMA networks. In an effort to retrofit the 2G standards for compatibility with increased throughput rates to support modern Internet application, the new data centric standards were developed to be overlaid on 2G standards and this is known as 2.5G standard.2.5G describes the state of wireless technology and capability usually associated with General Packet Radio Services (GPRS). GPRS is based on "packet switching" (as against "circuit switching" used by GSM) and is technically capable of delivering 144-170 Kbps.

However, the more realistic speeds could initially be 53.6–115 Kbps. The 2.5G's "always-on" web-access capability, coupled with much faster data speeds, makes the wireless web experience far easier and more pleasant. However, users will have to buy new GPRS capable phones/devices to take advantage of that. It also has the ability to allow operators to charge/bill users based on the amount of data sent/received per month, as against the time spent online. As per a survey, a new 2.5G service could boost an operator's Average Revenue Per User (ARPU) by 35 percent, depending on the services introduced. The likely moneymaking services include instant messaging, games and many business services. The whole business model is thus undergoing a change. For mobile networks, as voice becomes a commodity, data would be the differentiator to fight competition.

### C. Edge (Enhanced Data Rates for GSM Evolution or Enhanced GPRS)

EDGE technology was invented and introduced by Cingular, which is now known as AT&T. EDGE is a term occasionally used to refer to 2.75G data connectivity, implying that is faster than GPRS (2.5G) It is a digital mobile phone technology which acts as a bolt-on enhancement to 2G and 2.5G General Packet Radio Service (GPRS) networks. Edge allows transmission of data and information at fastest rate with enhanced quality. EDGE enhancement of circuit switched data communication is called ECSD (Enhanced Circuit Switched Data), which updates HSCSD for EDGE modulation in the radio interface. EDGE enhancement of packet switched data communication is called EGPRS (Enhanced GPRS). BTS and MS devices must be EDGE capable in GSM/GPRS system architecture. BTS units must be enhanced with EDGE Transcoding Units (EDGE TRU) due to the higher data communication rates.

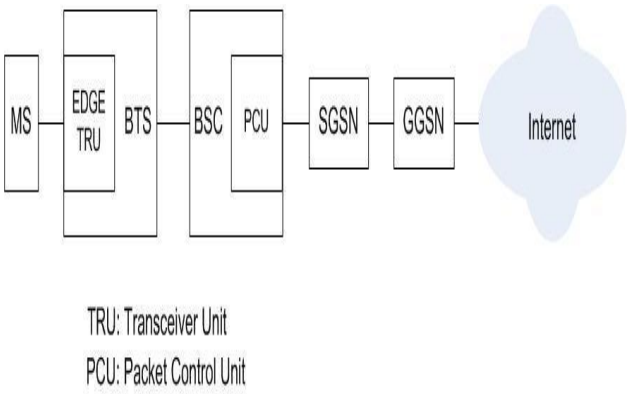


**Figure6. 2.75G EDGE Architecture**

**Table2: Features of 2G, 2.5G and 2.75G**

| Generations | 2G | 2.5 | 2.75 |
|---|---|---|---|
| Starts from | 1990 | 2000 | 2003 |
| Frequency | 850-1900 MHz(GSM) 825-849MHz(CDMA) | 850-1900 MHz | 850-1900 MHz |
| Data capacity | 10KBPS | 200 KBPS | 473 KBPS |
| Technology | Digital wireless | GPRS | EDGE |
| Standard | CDMA TDMA GSM | Supported TDMA/ GSM | GSM CDMA |
| Multiplexing | TDMA CDMA | TDMA CDMA | TDMA CDMA |
| switching | Circuit Packet | Packet | Packet |
| Service | Voice data | MMS internet | |
| Main network | PSTN | GSM TDMA | WCDMA |
| Hand off | Horizontal | | |

### D. 2.9G Mobile Network (Evolution of Edge)

The present speed of the transmission of data through edge can be doubled upto 1mb/s by using the same system architecture, protocol architecture and security architecture by tuning the performance of the radio interface. The enhancements to EDGE is included in the specification 3GPP TS 41.101.For some EDGE modulation and coding schemes, 8-PSK modulation (3 bits/symbol) is replaced with 16QAM (4 bits/symbol) and 32QAM (5 bits/symbol) modulation. Convolution error correction codes are replaced by more efficient 'turbo codes'. The narrow channel bandwidth of GSM is overcome be using two radio frequency carriers. This is the most significant improvement to peak data communication rates since the number of time slots used by end user terminals is redoubled.

The strength of received radio communication signal is sensitive to the position of the transmitter, the receiver, and other objects that scatter radio signals. This phenomenon, which is called fading, can in mobility make a radio signal too weak to be captured. Base stations have already used dual antenna systems against fading to improve the capturing of radio signals especially at radio cell borders. EDGE Evolution introduces dual antenna systems also in user terminals Conversational services such as VoIP and video conferencing require low latency of necessary handshake signaling. Such latency mainly depends on the TTI length. EDGE Evolution cuts TTI from 20 ms to 10ms. The latency of handshake signaling between a MS and BSC through a BTS is thus reduced from about 150 ms to about 100ms.

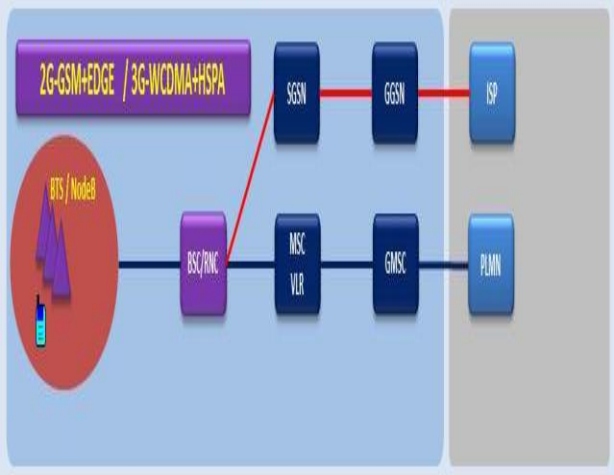


**Figure7.2G-GSM+EDGE/3G-WCDMA+HSPA Architecture**

## IV. THIRD GENERATION MOBILE NETWORK

The 3G Network was adopted by Japan and South Korea in 2001 for the first time. 3G is the next generation of wireless network technology that provides high speed bandwidth (high data transfer rates) to handheld devices. The high data transfer rates will allow 3G networks to offer multimedia services combining voice and data. It is based on the International Telecommunication Union (ITU) family of standards under the International Mobile Telecommunications-2000 (IMT-2000). ITU launched IMT-2000 program, which, together with the main dusty and standardization bodies worldwide, targets to implement a global frequency band that would support a single, ubiquitous wireless communication standard for all countries, to provide the framework for the dentition of the 3G mobile systems. Several radio access technologies have been accepted by ITU as part of the IMT-2000 framework. The 3G activities were initiated in Europe and North America under the respective names IMT0-2000 and CDMA-2000.These were based on wideband direct CDMA (WCDMA) and multi carrier CDMA. Both IMT0-2000and CDMA-2000 used FDD to support two way transmissions with frequency isolation.

### A. 3G Standards and Access Technologies

There is several different radio access technologies defined within ITU, based on either CDMA or TDMA technology. An organization called 3rd Generation Partnership Project (3GPP) as continued that work by defining a mobile system that fulfils the IMT-2000 standard. This system is called Universal Mobile Telecommunications System (UMTS). After trying to establish a single 3G standard, ITU finally approved a family of five 3G standards, which are part of the 3G framework known as IMT-2000.WCDMA is based on DS-CDMA (direct sequence code division multiple access) technology in which user-information bits are spread over a wide bandwidth by multiplying the user data with the spreading code. FoMA, was the world's first commercial W-CDMA service which was launched by NTT Do Como

in Japan in 2001. FoMA stands for Freedom of Mobile Multimedia Access, which is the brand name for the 3G services being offered by Japanese mobile phone operator NTT Do Como. Elsewhere, W-CDMA deployments have been exclusively UMTS based. UMTS or W-CDMA, assures backward compatibility with the second generation GSM, IS-136 and PDC TDMA technologies, as well as all 2.5G TDMA technologies.

The network structure and bit level packaging of GSM data is retained by W-CDMA, with additional capacity and bandwidth provided by a new CDMA air interface. The second network to go commercially live was by SK Telecom in South Korea on the 1xEV-DO (Evolution-Data Optimized) technology in January 2002 followed by another South Korean 3G network was by KTF on EV-DO in May 2002. In Europe, the mass market commercial 3G services were introduced starting in March 2003 by 3 (Part of Hutchison Whampoa) in the UK and Italy. This was based on the W-CDMA technology. The first commercial United States 3G network was by Monet Mobile Networks, on CDMA2000 1x EV-DO technology and the second 3G network operator in the USA was Verizon Wireless in October 2003 also on CDMA2000 1x EVDO. The first commercial 3G network in southern hemisphere was launched by Hutchison Telecommunications branded as three using UMTS in April 2003.

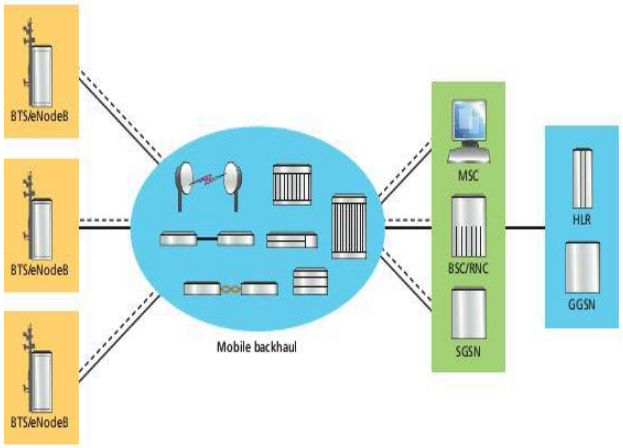


**Figure8. 3G Architecture**

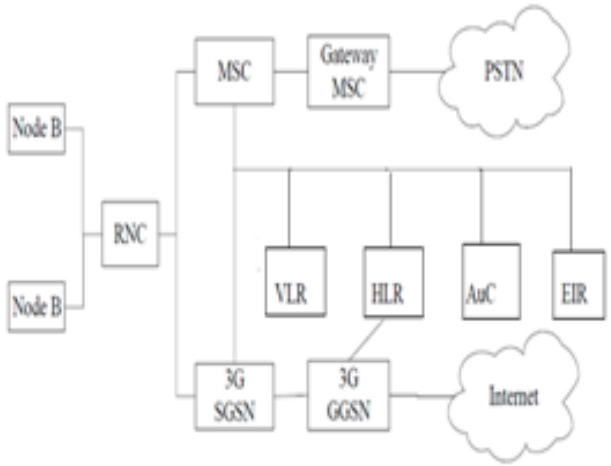


**Figure9. WCDMA Architecture**

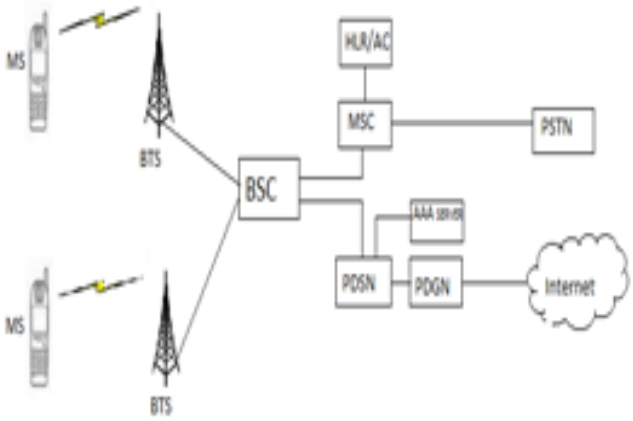


**Figure10. 3G CDMA 2000**

3G technology is also able to transmit packet switch data efficiently at better and increased bandwidth. 3G mobile technologies proffers more advanced services to mobile users. It can help many multimedia services to function. The spectral efficiency of 3G technology is better than 2G technologies.

**B. 3.5G–HSDPA(High-Speed Downlink Packet Access)**

High-Speed Downlink Packet Access (HSDPA) is a packet based data service in W-CDMA downlink with data transmission up to 8-10 Mbit/s (and 20 Mbit/s for MIMO systems) over a 5MHz bandwidth in WCDMA downlink. Its implementations includes Adaptive Modulation and Coding (AMC), Multiple-Input Multiple-Output (MIMO), Hybrid Automatic Request (HARQ), fast cell search, and advanced receiver design.

**C. 3.75G-HSUPA (High-Speed Uplink Packet Access)-**

High Speed Uplink Packet Access (HSUPA) is a UMTS / WCDMA uplink evolution technology, directly related to HSDPA and the two are complimentary to one another. HSUPA will enhance advanced person-to-person data applications with higher and symmetric data rates. It will initially boost the UMTS / WCDMA uplink up to 1.4Mbps and in later releases up to 5.8Mbps.

**Table 3: Features of 3G. 3.5G and 3.75G**

| Generations | 3G | 3.5 | 3.75 |
|---|---|---|---|
| Starts from | 2001 | 2003 | 2003 |
| Frequency | 1.6-2.5GHz | 1.6-2.5GHz | 1.6-2.5GHz |
| Data capacity | 384Kbps | 2Mbps | 30Mbps |
| Technology | Broad band /IP technology FDD TDD | GSM/ 3GPP | |

### D. Generation Mobile Network (4G)

3G may not be sufficient to meet needs of future high-performance applications like multi-media, full-motion video, wireless teleconferencing multiple standards for 3G make it difficult to roam and interoperate across networks. Requirement of a single broadband network with high data rates which integrates wireless LANs, Bluetooth, cellular networks, etc 4G-also known as "Beyond 3G", 4G refers to the fourth generation of wireless communications. The deployment of *4G networks* should be in the 2010-2015 timeframe and will enable another leap in wireless data-rate and spectral efficiency. ITU has specified IMT-A (IMT-Advanced) for 4G standards.4G is all about convergence; convergence of wired and wireless networks, wireless technologies including GSM, wireless LAN, and Bluetooth as well as computers, consumer electronics, communication technology and several others. 4G is a Mobile multimedia, anytime anywhere, Global mobility support, integrated wireless solution, and customized personal service network system 4G wireless technology is also referred to by "MAGIC" which stands for Mobile multimedia, Any-where, Global mobility solutions over, integrated wireless and Customized services

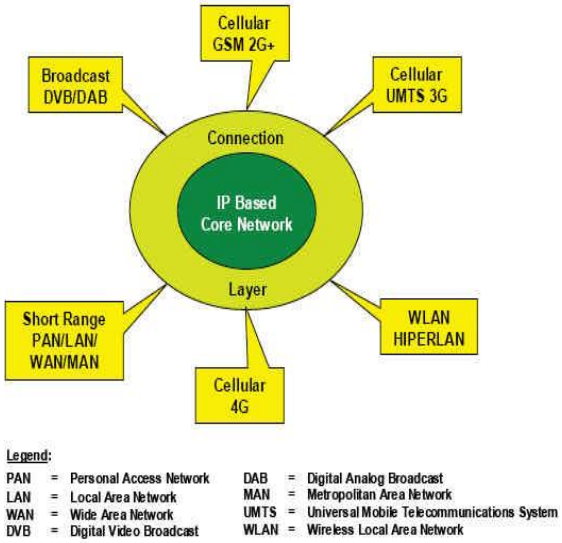


**Figure11. 4G-IP Based Core Network**

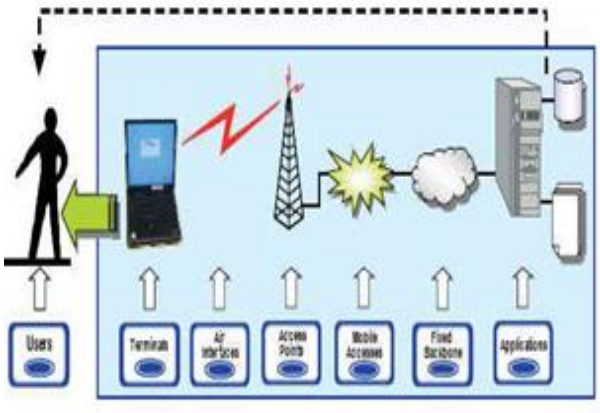


**Figure12. 4G Mobile Communication**

### E. 4G Over 3G

3G technologies are in widespread use while 4G compliant technologies are still in the horizon. The biggest difference between the two is in the existence of compliant technologies. There are a bunch of technologies that fall under 3G, including WCDMA, EV-DO, and HSPA among others. Although a lot of mobile phone companies are quick to dub their technologies as 4G, such as LTE, WiMax, and UMB, none of these are actually compliant to the specifications set forth by the 4G standard. These technologies are often referred to as Pre-4G or 3.9G

**Table 4: 3G Vs 4G**

| Parameters | 3G | 4G |
|---|---|---|
| Network Architecture | cell-based | Integration of various wireless technologies |
| Speeds | 384 Kbps to 2 Mbps | 100 Mbps to 1 Gbps |
| Frequency Band | Dependent on country or continent (1800-2400 MHz) | Higher frequency bands (2-8 GHz) |
| Bandwidth | 5-20 MHz | 100 MHz (or more) |
| Switching Scheme | Circuit and Packet | Packet |
| Access Technologies | W-CDMA, 1xRTT, Edge | OFDM and MC-CDMA |
| IP | No. of air link protocols | All IP (IP6.0) |

### Migration to 4G:

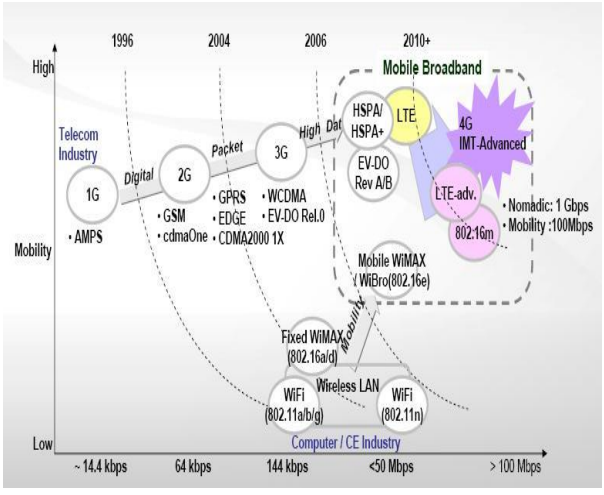


**Figure13. Migration to 4G**

## V. CONCLUSION

4G seems to be a very optimistic generation of mobile networks that will change the people's life to wireless world. In these paper we have discussed about the envisage of mobile network and the evolution of different mobile network which were used in the past. The next era of mobile wireless network is totally acquired by 4G. The Fourth Generation have many striking attractive features proposed for 4G which ensures a very high data rate, global roaming etc. New ideas are being introduced by researchers throughout the world, but new ideas introduce new challenges. The last few years have spotted a phenomenal growth in the wireless industry. The ever increasing demands of users have triggered researchers and industries to come up with a comprehensive manifestation of the up-coming fourth generation (4G) mobile communication system Someday 4G networks may replace all existing 2.5G and 3G networks.

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