MOBILE TECHNOLOGY: A STUDY ON ITS EVOLUTION

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ABSTRACT

Communication is a process in which information is transferred from source to destination. Information can be in any form – Voice, Data, Video, Graphics etc. Voice Communication is the simplest form of communication. We have been using communication technology for years. Communications, or telecommunication, technology consists of electromagnetic devices and systems for communicating over long distance. The principle examples are telephone,radio, television etc. This paper deals with the evolution of one of the most fundamental element of today's communication world that is, mobile technology. The main aim of this paper is to examine the need of mobile technology and the reasons that led to its evolution over decades.

Keywords: Mobile Technology, Need of Mobile Technology, Evolution (0G, 1G, 2G, 3G, 4G and Beyond 4G), GSM Architecture

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Introduction

The term 'Mobile' basically refers to mobility. Mobile technology allows the users to communicate with each other without any geographical boundations. The roots of mobile technology goes back to 1940s when Motorola in conjunction with the Bell System introduced the first commercial mobile telephone service Mobile Telephone System (MTS) in the US in 1946. Since then, a number of advancements have been made in this field which has led to the introduction of different generations of mobile technology.Before the mobile systems came the landline in the year 1970 by three nations: Japan, North America and Europe. All the three nations worked together on it and the landline system started in 1980's.Though they served the basic purpose of information transfer from the source to destination still there were certain limitations that led to a move toward mobile technology.

Need of Mobile Technology

- **Range:**Range of a landline was equal to the range of a local exchange which is nearly that of a city.Hence need of mobile technology came into existence. Mobiles using the concept of handover have a wide range which can be across the world.
- **Capacity:**Capacity of a landline system was merely of a few caller as there was limited frequency available. Mobiles using the concept of frequency reuse can use the same frequency at different geographical locations hence increasing the communicating capacity.
- **Interference:**The main reason for the introduction of mobile technology was to overcome the problem of cross talk or interference which was very frequently reported in landline communication due to its low call handling capacity.
- **Mobility:**Landlines were immobile and cannot be carried to all the places. Comparatively,mobiles have an advantage of mobility that is; they can be carried all along.
- **Services:**Mobile systems provide a wide range of services like messaging, internet etc. which were absent in landline. These features proved to be a great advantage of using Mobile Technology.

Evolution of Mobile Technology

- **0G (Zero Generation Mobile Radio Telephone System):**0G is also known as Mobile Radio Telephone system**.**It was analog in nature and was also known aspre cellular system.0G system provided half duplex communications that is,only one person could speak at a time using the Push To Talk (PTT) technology. The so-called "mobile systems" were mainly installed in vehicles, with a bulky transceiver and a handset and a dialer. This allowed users to stay connected while out and about with their vehicles. Technologies such as Advanced MobileTelephone System **(**AMTS**),** Mobile Telephone System **(**MTS**),** MTD **(**Mobile telephony system D**)** andImproved Mobile Telephone Service **(**IMTS) were also used in this system. Though 0G served the basic need of mobile communication;its range was limited only up to 20KMs. There was also limitation on the number of users to use this device as only 25 channels were available.Roaming facility was also not supported in this generation.Large number of limitations in this generation led to the evolution toward 0.5 generation.0.5G was the advance version of 0G. Early examples for this technology were:

- The Autoradiopuhelin (ARP) was launched in 1971 in Finland as the country's first public commercial mobile phone network. It was operated on 8 channels with a frequency of 150 MHz(147.9 – 154.875 MHz band).Its transmission power was in a range of 1 to 5 watts. ARP also used half duplex system like 0G, but with manual switched system.
- The B-Netz launched in 1972 in Germany as the countries second public commercial mobile phone network; but it was the first one that did not require human operators anymore to connect calls.

ARP did not support thehandover and hence calls would get disconnected while moving from one cell to another. However, the attracting feature of ARP was that it provided 100% coverage within a cell. ARP was successful and became very popular until the network became congested and were also very expensive. These limitations led to move toward an advanced mobile generation which came to be known as First Generation Mobile System.

- **1G (First Generation Mobile System):** 1G signifies first-generation analog wireless technology that originated in the 1980s. It was more improved and faster over 0G and provided speed of 9.6 Kbps(Kilo Bits Per Second).First generation mobile systems were primarily used for voice calls.This technology comprised of Analog Radio Signals for its working. However,it used digital signaling to connect the radio towers to the rest of telephone system, using FDMA (Frequency Division Multiple Access) technique.Here, a voice call gets modulated to a higher frequency of about 150 Mhz and is then transmitted between radio towers.These services are provided through Circuit Switching,that is, a path is setup prior to transmission of message data and then the entire message travels via same path from source to destination.There were different 1G standards prevalent such as:

- **AMPS (Advanced Mobile Phone System):** It was a cellular standard introduced in 1983 using FDMA multiple access technique, working in Frequency band of 824-894 MHz, at a channel bandwidth of 30 KHz using FM modulation technique.
- **NMT (Nordiac Mobile Telephone):** It wasadopted by Nordiac countries, Switzerland, Netherlands, Eastern Europe and Russia.
- **TACS(Total Access Communication System)**
- **C- 450**

1G mobile systemwere advantageous over 0G but still there were two prime concern in its use-Interference and Security.Due to implementation of FDMA technique,there was interference in the system and also no security was provided to the data being transmitted which increased the chances of data hacking.Also 1G did not provided users with data services. These limitations were the roots for moving toward second generation of mobile technology.

- **2G (Second Generation Mobile System**): 2G signifies Second Generation of mobile Technology.This system was digital in nature and it provided users with voice as well as data services. Digital radio transmission gave a possibility of easy Encryption and Decryption thus providing higher data security compared to previous mobile systems. Digital transmission also improved System Capacity making possible compressions and

efficient data multiplexing. There was more efficient spectrum utilization over previous standards.2G technologies can be divided into:

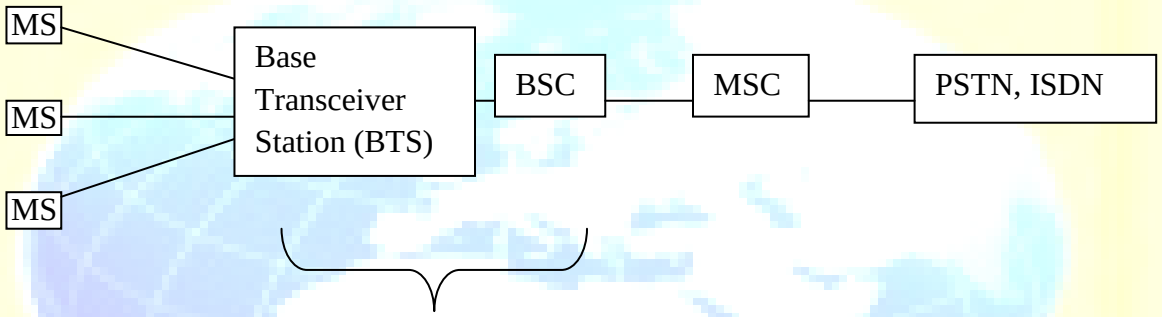
- **TDMA (Time Division Multiple Access):** TDMA standards included GSM (Global System Mobile) in which entire band was divided into 200 KHz wide ARFCNs. TDMA standard supported eight time slotted users for each 200 KHz radio channel.Other standards were Interim 136 which supported 3 time slotted users for each 30 KHz radio channel and PDC(Pacific Digital Cellular).
- **CDMA (Code Division Multiple Access):** CDMA standard supported 64 users that were orthogonally coded and simultaneously transmitted on each 1.25 MHz channel.

Though 2G proved to be advantageous over previous generations there were problems such as Near Far Problem caused by CDMA which was an issue of concern. Besides; the demand for faster speed led to the advancement in 2G technologies and it was evolved to 3G through intermediate standards defined within 2.5G and 2.75G. These included four intermediate standards

- **HSCSD (High Speed Circuit Switched Data):** This circuit switched technique allowed a single mobile subscriber to use consecutive user time slots in GSM standard. That is, instead of limiting each user to only one specific time slot in GSM TDMA standard HSCSD allows individual data users to use consecutive time slots in order to obtain higher speed data access on the GSM network.It also reduced error control coding algorithms originally specified in GSM standard. Data rate was increased to 14,400bps, as compared to original 9600 bps in GSM specification.
- **GPRS (General Packet Radio Service):** GPRS is also known as 2.5G .It provides users with a speed of 144 Kbps which is much faster compared to previous standards. GPRS is a packet based data network , which is well suited for non real time Internet usage, that is, the retrieval of email, faxes, and asymmetric web browsing etc.Implementation of GPRS merely requires the GSM operators to install the new routers and Internet Gateways at the base station, along with new software that redefines the base station air interface for GPRS channels and time slots- no new base station RF hardware is required.

- **EDGE(Enhanced Data Rates for GSM Evolution):**It is also known as 2.75G.It gives a speed of 374 kbps. EDGE introduced a new digital modulation format, 8-PSK (octal phase shift keying) which is used in addition with GSM standard GMSK model.
- **IS-95B:**It is already being deployed worldwide, and provides high speed circuit and packet switched data access on a common CDMA radio channel by dedicating multiple orthogonal user channels for specific users and specific purposes.It supports 64 different user channels with data rate of 14,400 bps.

GSM Architecture



Base Station Subsystem (BSS)

MS is Mobile Station that is basically the user equipment. The interface between MS and BTS is known as the Air Interface. BSC is Base Station Control whereas MSC stands for Mobile Switching Centre. The interface between BTS and BSC is known as Abis interface.

- **3G (Third Generation Mobile System):** 3G is the Third Generation of Mobile telecommunication technology which provides speed of 2 Mbps .It is also known as UMTS.3G provide its users with a number of data services-Mobile video, music downloads, e-mails, messaging and Internet services are just few of many applications that users have access to. 3G networks offer greater security than their 2G predecessors. By allowing the UE (User Equipment) to authenticate the network it is attaching to, the user can be sure the network is secured. It also employs KASUM block cipher to encrypt the data which is much secured and cannot be easily deciphered by the intruders. The common standards that comply with the 3G standard are EDGE combined with the GPRS

2.5 technology called as EGPRS which allows peak data rates of 200 Kbit/s. Evolved EDGE is the latest version having peak of 1 Mbit/s downstream and 400 Kbit/s upstream. Another is UMTS (universal Mobile Telecommunication System) and W-CDMA which operates in 2100 MHz. band. Further enhancements like HSPA offers speed of 14.4 mbps downstream and 5.75 Mbps upstream .Furthermore HSPA+ provide theoretical data rates up to 168 mbps downstream and 22 Mbps upstream. The high speed 3G network hence gives rise to applications that were not previously available to mobile users such as Mobile TV, Video On demand, video Conferencing,telemedicine, Location Based Services etc. However 3G may not be sufficient to meet the needs of future high-performance applications like multimedia, full-motion video and wireless teleconferencing. This demands for an improved technology and is a way for the fourth generation mobile systems.

- **4G (Fourth Generation mobile system):**4G is also known as "Beyond 3G". Another name for 4G is LTE.It refers to the fourth generation of wireless communications. The LTE specification provides downlink peak rates of 300 Mbit/s and uplink peak rates of 75 Mbit/s.4G is all about convergence; convergence of wired and wireless networks. 4G wireless technologies is also referred as "MAGIC" which stands for Mobile Multimedia, Anywhere, Global Mobility Solutions over Integrated Wireless and Customized services. 4G is an all IP-based integrated system will be capable to provide 100 Mbps for high mobility and 1 Gbps for low mobility, with end-to-end QoS and high security, and will be offering various services at any time as per user requirements, anywhere with seamless interoperability, at affordable cost. The user services include IP telephony, ultra-broadband Internet access, gaming services and High Definition Television (HDTV) streamed multimedia. While 3G was basically a mobile telephony system, 4G is an integration of various Wireless technologies.It works on a packet switching technology with speed defined in range from 100Mbps to 1Gbps. Bandwidth is taken as 100 MHz or more.Access technologies that are used are OFDM and MC-CDMA.A 4G system provides Mobile Ultra broadband Internet Access, for ex: to smartphones, to laptops with USB Wireless Modems, and to other Mobile Devices.Two standards are available for use in 4G technology system-Mobile WiMax, IEEE 802.16e standard- It offers a peak data rates of 128Mbits/s downlink and 56Mbit/sec uplink over 20 MHz voice channel. This

standard was first implemented in South Korea in 2006. Another is Long Term Evolution (LTE) Standard- It was first implemented in Oslo, Norway and Stockholm, Sweden since 2009. It employs OFDMA for the downlink and SC-FDMA for the uplink to conserve power.MetroPCS was the first operator to offer LTE service in 2010. LTE smartphones have been available since 2011.In India; BhartiAirtel has launched India's first 4G service using TD-LTE technology in Kolkata on 10th April 2012. Also, Reliance Industries Limited(RIL) is planning to launch its 4G service under the name Reliance JioInfocomm.

- **Moving Beyond 4G:** 4G is not the end of all. One of the main concerns about 4G is that due to high speed of the frequency, it will experience severe interference from multipath secondary signals reflecting off other objects. To counter this problem, a number of solutions have been proposed, including use of a variable spreading factor and orthogonal frequency code-division multiplexing.Next comes the problem of non-compatibility of various applications.Due to these reasons,"5G Technology" is already in research arena and is bound to up the data rate further.5G is going to alter the way of our usage of our cellphones; may replace our Desktop PCs/laptops. Coupled with innovations being done in the field of smart sensors, 5G mobile phones with extremely high data rates, IP core, and world-wide coverage will offer features which have not imagined so far. Currently 5G is not a term officially used for any particular specification, however, it is being used in research papers and standardization bodies for the future wireless standards.

Conclusion

The paper presents the evolution of mobile communication –its origin and advancements that are made in this field as per user's demands. Mobile technology has achieved a significant success in making our lives much simpler and easier by providing the means of communication anywhere, anytime. From the roots of analog based first generation service (1G) to today's truly broadband-ready LTE networks;the wireless industry is on a path that promises some great innovation in the future.

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