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Globalised Telecom Revolution: A Survey of Wireless Communication technology

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Abstract: Mobile communications systems revolutionized the way of people communication, joining together and mobility during conversation. The word telecommunication is formed from the words TELE (bridging large distance) and COMMUNICATION (Conversation).Telecom has attracted many users and undergoing numerous changes, from half duplex to point-to-point , short message services , conferencing , video calling , point-to-multi-point Internet connectivity to high speed data transfer from (9.6 Kbps to 100 Mbps). In this Paper we abstracting the evolution and development of various generations of mobile wireless technology along with their significance performance of one over the other and some of the important issues pertaining to the evolution of mobile communication networks from 0th generation (which was the initiation of wireless communication).The first generation has fulfilled the basic mobile voice, while the second generation has introduced capacity and coverage. 2G followed by the third generation, which has quest for data at higher speeds to open the gates for truly "mobile broadband" experience. It was further realized by the fourth generation (4G).The Fourth generation is providing access to wide range of telecommunication services, including advanced multimedia application supported by mobile and fixed networks, which are increasingly packet based, along with a support for low to high mobility applications and wide range of data rates. 5G technologies will change the way most high- bandwidth, users can access the services in Product Engineering, Documentation, supporting electronic transactions.

Keywords: Frequency bands, distortion, Handover, communication channels, channel access methods, Antenna, Tilt, network component and optimization

I. INTRODUCTION

The Lord Shri Krishna said in our "BHAGVAT GEETA" that everything of this universe created, grows give a path to its new generation and destroy. This is the universal natural law of development also applied in technology growth. Wireless communication is the transfer of information (text, image, audio, video) in a compressed format over a distance without the use of enhanced electrical conductors or "cables". The distances involved may be short (a few meters as in Bluetooth ,infrared ,walky-talky ,television remote control) or long (thousands of kilometers for radar ,radio communications through satellite).It encompasses various types of phone and computer (landline phone, mobile, and portable two-way radios cellular telephones, Personal Digital Assistants ,tablet Pc) **[1]** . The theory of electromagnetic radiation was propounded by Clark Maxwell in 1857 which explained mathematically the behavior of electromagnetic waves. Then G. Marconi Invented trans-Atlantic radio transmission using electromagnetic waves in 1901.In 1920 several police departments in US began to use radiotelephony. Though it had some success at that time, it was not suitable for on-land communication. The equipment was extremely bulky and faced many problems of obstacles like buildings .The 1G technology which made the large scale mobile wireless Communication possible. Digital communication has replaced the analogy technology in the 2G which significantly improved the wireless communication quality. Data communication, in addition to the voice Communication, has been the main focus in the 3G technologies and a converge network for both voice and data communication emerged with continued R&D, there are many beautiful application opportunities for the 4G technological challenges.

II. 0G MOBILE TECHNOLOGY 1946

Wireless telephone started after Second World War with a handful of channel availability known as 0G telephony technology. 0G refers to pre cell-phone telephony technology. zero generation systems included MTS (Mobile Telephone System),PTT (Push to Talk), IMTS (Improved Mobile Telephone Service), AMTS(Advanced Mobile Telephone System), OLT(Norwegian for Offending Land mobile Telephone , Public Land Mobile Telephony) and MT(Mobile telephony system).These early mobile telephone systems were available in commercial service which belongs to the Public Switched Telephone Network, with their own telephone numbers, rather than part of a closed network such as a police wireless radio or ambulance dispatch system. They were sold through WCCs (Wire line Common Carriers, AKA

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telephone companies), RCCs (Radio Common Carriers), and two-way radio dealers.

1.Finland was the first country in the race of launching first commercial mobile phone services.

2. Second public commercial mobile phone automatic network was launched by The B-Netz in 1972 in Germany [1]. In this technology, the radio telephone system contained one central antenna tower per region. The central antenna required radiophones to have a powerful transmitter, capable of transmitting up to 50 miles. The number of radio telephones per region was limited by the number of available channels. Motorola in collaboration with the Bell System operated the first commercial mobile telephone service, Mobile Telephone System (MTS) in the US in 1946, as a service of the wire line telephone company. The A-Netz launched in West Germany in 1952 as the country's first mobile phone network. In UK first mobile phone launched in 1959 it was manual and with very little coverage. First automatic system was the Bell System's IMTS which came in existence in 1962, offered automatic dialing to and from the mobile.

Fig-1 (*mobile installed in car*)

"Altai" mobile telephone system had been launched into the experimental service in 1963 in USSR and became fully automatic operational in 1965, a first automatic mobile phone system in Europe. The Televerket opened its first manual mobile telephone system in Norway in 1966. Norway was later the first country in Europe to get an automatic mobile telephone system. Roaming was not encouraged in part because there was no centralized industry billing database for RCCs but the Signaling formats were not standardized. Some radio equipment used with RCC systems was half-duplex, push-to-talk equipment such as Motorola hand-held's or RCA 700-series conventional two-way radios. Other vehicular equipment had telephone handsets, rotary or pushbutton dials and operated full duplex like a conventional wired telephone. A few users had full-duplex briefcase telephones, RCCs used paired UHF 454/459 MHz and VHF 152/158 MHz frequencies near those used by IMTS. Using the same channel frequencies as IMTS the US Federal Communications Commission authorized Rural Radiotelephone Service for fixed stations [4, 3].

A. 0G Mobile Technology Services

In Zero Generation, telephony was not available publically for individually due to limited number of channels. These telephones system were available for primary emergency services like ambulance, police wireless radio and every police station was using its different telephone number.

III. 1G MOBILE TECHNOLOGY (1979-80 to 1990)

The first-generation of wireless telephone technology was the **analogy** (continuous signal communication system) system introduced in the 1979-1980s. The first commercially automated cellular network (the 1G generations) was launched in Japan by NTT (Nippon Telegraph and Telephone) in 1979, initially in the metropolitan area of Tokyo In 1981. This was followed by the simultaneous launching of the Nordic Mobile Telephone (NMT) system in Denmark, Finland, Norway and Sweden. In USA the AMPS was launched in 1982 with 832 channels on 800 bands

Fig-2 *(first 1G mobile phone)*

A. Frequency Bands

- Nippon telephone and telegraph "NTT" was Operating on 450 MHz (1979)
- Nordic Mobile Telephones (NMT) and AMPS was Operating on 800 MHz band

B. Handover

- Inter cell handover
- Intra cell handover

Both handover were used but handover quality was poor. Roaming and Handover were applied in own country network but between countries was not applied.

C. Antenna

Omni directional antenna was used in the earlier implementation in first generation. Later it was realized that the directional antennas were better to utilized for cluster coverage & cell reusability and the smallest reuse factor that would fulfill the 18db signal-to-interference ratio (SIR), but when 120-degree directional antennas was used reduced SIR
was found to be only 7,hence in 1988, 7 cell reuse pattern was adopted by AMPS[2]

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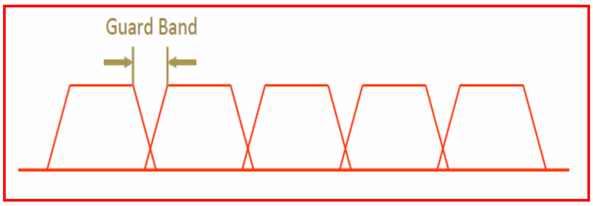
D. Noise and Distortion

Noise was the major limitation of communication channel in first generation. Noise could not remove completely but there are several modulation techniques which can reduce noise to a greater extent.

E. Channel Access Method

AMPS and TACS both use the frequency modulation (FM) technique and Traffic is multiplexed on FDMA (frequency division multiple access) for radio transmission.1G wireless networks used analog radio signals so through 1G, a voice call gets modulated to a higher frequency of about 150MHz and above as it is transmitted between radio towers.



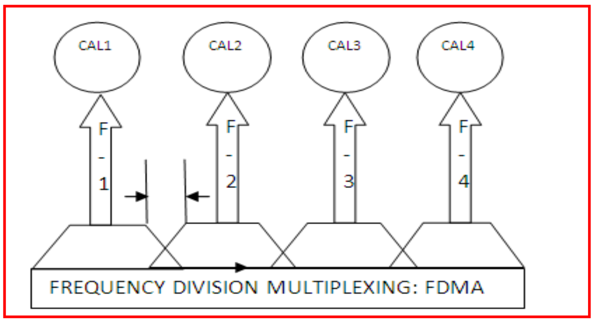


Fig-3 (*frequency division multiple access*)

Each mobile is assigned a separate frequency channel for the duration of the call and sufficient guard band is required to prevent adjacent channel interference. Usually, mobile terminals will have one downlink frequency band and one uplink frequency band [3].

F. 1G Technology Services

First generation cellular technology was using FDMA so limited number of mobile phones was being used publically. It was costly but initiation of telephony so it gave revolutionary change in wireless communication opportunity research areas.

1g offered voice calls only and a data rate from 2.4 kbps to
10kbps.

G. 1G Network Optimization

While a call made in 1G technology had generally poor quality but it survived longer distances. The RX Level, RX quality, Call quality and speech quality was poor because SNR (signal to noise ratio) and SIR (signal to interference ratio) was the worst. In analog cellular technology Maximum data rate was 2.4kbps and allow voice calls only, it was allowing limited call due to limited no of Channel availability. In the end of 1g AMPS used 832 Channel and offered a data rate of about 10kbps in around 1987-88. Most of the calls were dropped due to poor coverage, missing neighbor and handover failure. Analog technology provide, low network throughput, high latency, high operating cost and minor security, though the mobile market showed annual growth rates of 30 to 50 percent, rising to nearly 20 million subscribers by 1990.

IV. SECOND GENERATION (1990)

Group Special Mobile within the CEPT started developing GSM in 1982. Later it was standardized by the ETSI and branded as a Global System for Mobile (GSM). These systems are called GSM for Europe and IS-136 for US .To provide a single unified standard the Global System for Mobile Communications (GSM) was commercially launched on the GSM standard in Finland by Radiolinja (now part of Elisa Oyj) in 1991.GSM is the most successful family of cellular standards, 450million mobile subscribers with international roaming in approximately 170 countries and 400 networks. The development of GSM technology was driven to improve transmission quality, system capacity, network security, microwave devices and further advances in semiconductor technology and brought digital transmission to mobile communications [1, 4].

A. *Network Component*

The network component of 2G System are the BSS (Base Station Subsystem) contain many BSC (Base Station Controllers) ,every BSC contain many BTS (Base Transceiver Station), the NSS (Network Switching Subsystem), MSC (Mobile Switching Centre), VLR (Visitor Location Register), HLR (Home Location Register), AC (Authentication Centre) and EIR (Equipment Identity Register). GSM and VAS (Value Added Services) the next advancement in the communication system was the addition of two services, called Voice Mail Service (VMS) and the Short Message Service Centre (SMSC).Speech was transmission still dominating the airways but the demands for fax, short message, and data transmissions, encrypting become standard features that are needed to those in fixed and wireless networks [5, 6].

B. *Frequency Bands*

GSM was specially designed for 900 MHz band but in some countries available in 800MHz band. It keeps 45 MHz Duplex spacing and 200 kHz carrier spacing.

TABLE I

GSM Type	Frequency Band	
	UPLink(UL)	Downlink(DL)
GSM800	821-849 MHz	869-894 MHz
GSM 900	890-915 MHz	935-960 MHz

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GSM 1800 (DCS 1800)	1710-1785 MHz	1805-1880 MHz
GSM 1900 (PCS 1900)	1850-1910 MHz	1930-1990 MHz

In radio frequency if two signals having different frequencies are transmitted with same power, the signal with low frequency will travel much far than the signal with higher frequency and Propagation losses will be less for low frequency as compared to a higher one. Hence if a GSM 900 frequency and a DCS 1800 frequency are transmitted with same power then DCS 1800 frequency will cover only half of the area covered by GSM 900 frequency [6, 8].

A. *Communication Channels*

A communication channel is the medium, used to electrically connects transmitter to receiver .the property of communication channel strongly influence the performance of communication System.GSM using Two types of channels

- Physical Channel (200 KHz frequency carrier consist of 8time slot)
- Logical Channel (Logical channel is further divided as)[8].

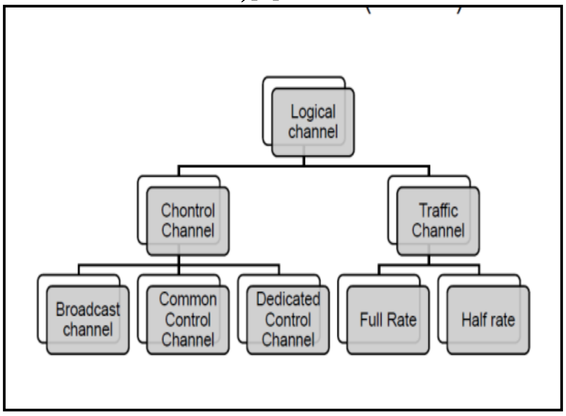

Fig-3 *(GSM channels)*

B. *Antennas*

Omni directional antenna was replaced by direction antenna (120degree).it provide high antenna gain. Whole cluster is divided into three sectors 0-120degree, 120-240 degree, and 240-360degree depends on the cluster density. Cluster can also divided in four sectors of 90 degree in the high capacity area. Antennas enable good coverage, cell reusability and high performance in transmission & receiving signals.

E. *Tilt*

Antenna Tilt is used to reduce interference and fill the coverage gap in cluster. Two types of tilt are used electrical tilt and mechanical tilt.

F. *Handover*

- Intra cell handover –transferring of call request or reply from one sector to another sector within same site
- Inter cell handover – transferring of call request or reply from one sector to another sector of different site.
- Intra BSC handover and Intra MSC handover – MS moves from cell to another cell from different BSC within same MSC
- Inter MSC handover –MS moves from cell to another cell from different BSC and different MSC [8]

G. *Intra BSC Handover*

In the same manner handover is also applied in MSC based Handover. Handover is also further divide in two types of SOFT HANDOVER and HARD HANDOVER. The given diagram showing an intra BSC handover between two base station A and base station B. Mobile subscriber is moving from site A(caller) to toward Site B(receiver) . This call can be made by a fixed host (land line) or as well as moving host (mobile subscriber).During motion of mobile subscriber if the receiver is latch to caller's BTS with same or different cell then handover became the intra cell handover. When the caller and receiver both are attached to different cells of different site there will be inter cell handover.

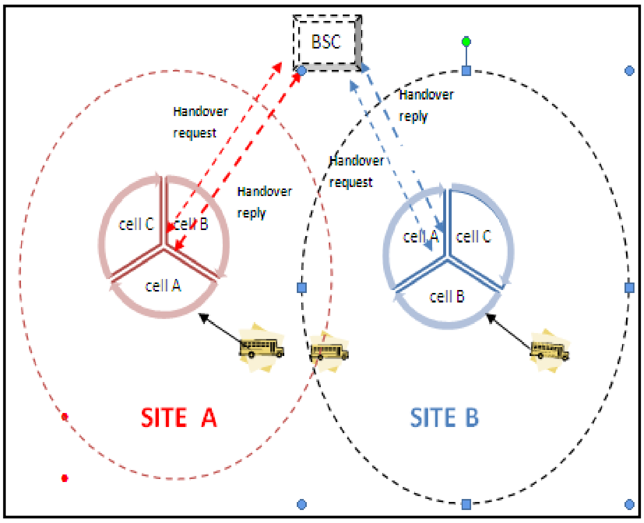

Fig-4 *(intra BSC handover)*

H. *Channel Access Duplex Method*

The BTS required serving for many mobile terminals instantly for handling maximum incoming and outgoing calls. Compared to analog system GSM use digital

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multiple access technology, TDMA (time division multiple access) and CDMA (code division multiple access) to provide higher spectrum efficiency, better data services and to increase mobility of subscriber in the required cluster. The more advanced international roaming was offered by 2G systems which was drawback of analogy system. In the starting of digital telephony GSM used TDMA in 1990.

I. Time Division Multiple Access

TDMA *IS-136* is the digital enhancement of the analogue AMPS technology. In TDMA Technology time frames are divided in the time slots, and one time slot is offered for two calls in FCFS order. There are 8 time slot in a TDMA frame and 1 time slot allow 2 calls hence one frame of TRX allowed 2x8=16 calls but one time is reserved so one TDMA frame allowed only 15calls at a time.8 time slots per carrier: 576.92 µs x 8 = 4.615 ms frame duration Control slot multi frame = 51 TDMA frames Traffic slot multi frame = 26 TDMA frames (120 m sec)

- **Super frame** = 26 x 51 multi frames (6.12 sec)
- **Hyper frame** = 2048 super frames (~ 3.5 hours)

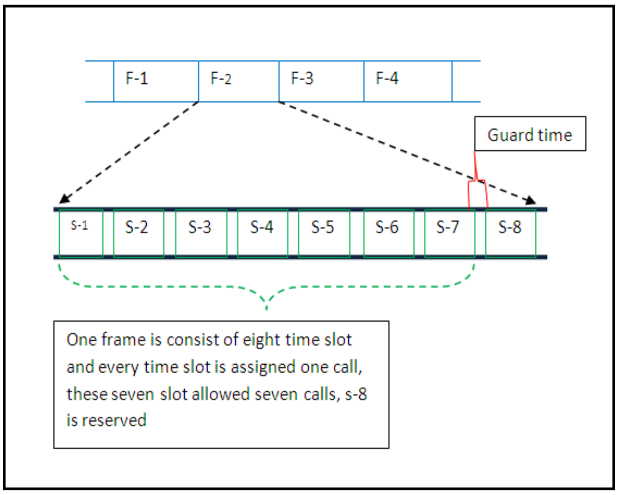

Fig-5 (*frequency division multiple access)*

The digital signal require less battery power consumption then analog signal so it is also use full in power saving. The actual revolution of telecom was brought by the GSM [7].

F ig-6 (*2G mobile phone of SIEMENS*

J. Code Division Multiple Access

CDMA employs spread-spectrum technology and special coding scheme to allow multiple users to be multiplexed over the same physical channel.

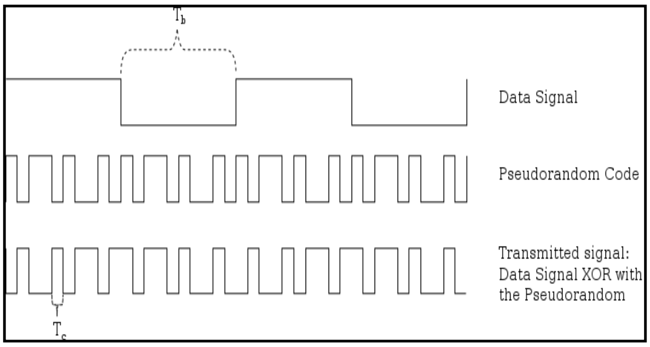

Fig-7 (*Code Division Multiple Access*)

A spread spectrum technique spreads the bandwidth of the data uniformly for the same transmitted power. A spreading code is a pseudo-random code that has a narrow ambiguity function, unlike other narrow pulse codes. In CDMA a locally generated code runs at a much higher rate than the data to be transmitted [10].

K. *GSM Architecture*

GSM Architecture consist of base station subsystem (BTS, BSC), network and switching sub system (MSC,HLR, VLR, GATE WAY), PSTN.

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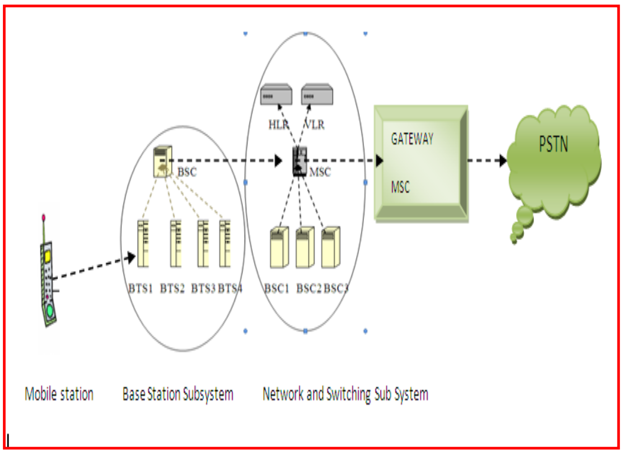

Fig-8 (*GSM Architecture)*

L. *GSM Nanocell*

The NanoCELL is miniature GSM base station that establishes cell phone services where ever capacity or coverage is needed. Nanocell is an FCC approved Device and can be installed with internet protocol (IP) switches, public switched telephone network or satellite transmission system. There is no limit to number of users, Up to 7 voice handset may access the one network same time [9].

M. *GSM Services*

GSM services are standard and collection of applications and features available to subscribers all over the world.GSM fulfilled various desired need of subscribers. Voice calls – incoming & out going calls Routing the calls-Whenever HLR receive any query it determine weather the call should be diverted (routed) or routed directly to the mobile user. Locating and ringing the phone Data transmission Circuit-switched data protocols General Packet Radio Service (GPRS)- Short Message Service (SMS) Blue Booth

Supplementary Services-

Call forwarding, Barring of Outgoing Calls, Barring of Incoming Calls, Call Hold, Call Waiting, call conferencing services, Calling Line Identification presentation/restriction, Closed User Group (CUG), Explicit Call Transfer .

N. *GSM Optimization*

The GSM developed to replace circuit switched network, optimized for full duplex voice telephony.GSM expanded for data communications, first by circuit switched transport(1985), then packet data transport via GPRS (General Packet Radio Services-**1995**) and EDGE (Enhanced Data rates for GSM Evolution or EGPRS-1999).GSM Offered data rate 14.4kbps and short message services. While next updating of GSM offered EDGE, GPRS, higher capacity, packetized data and data rate up to 384kbps. In GSM Network Optimization following are the key performance parameter Call Success Rate(CSR), SDCCH Blocking Rate, TCH Blocking Rate Call Setup success rate(CSSR), Call Drops ,Handover Test, GPRS, EDGE, FTP Test, Ping test, Rx level , Rx quality, SQI[11].

V. THIRD GENERATION-2000 (WCDMA IN UMTS, CDMA2000 & TDSCDMA)

In the second plus generation (2.5G EDGE) high volume data can be transfer ,but still the packet transfer on the air-interface behaves like a circuit switching call and circuit switching was not much efficient. In EDGE the technology development was not globalised hence, it was decided to design a network with a globalised design standard. The International Telecommunication Union (ITU) defined the design for 3G mobile networks with the IMT-2000 standard, and an organization 3rd Generation Partnership Project (3GPP) continued that work by defining a mobile system that fulfilled the IMT-2000 standard. In Europe it was called UMTS (Universal Terrestrial Mobile System). IMT2000 is the ITU-T name for the third generation system, while cdma2000 is the name of the American 3G**.** Generally 3G standards were developed by regional standards developing organizations (SDOs**)** [2, 12]**.** In 1998 SDOs Summit issued 17 proposals for ITU, in which 11 proposals for terrestrial systems and 6 for mobile satellite systems (MSSs). All 17 proposals have been accepted by ITU as IMT–2000 standards**.** The specification for the Radio Transmission Technology (RTT) was released at the end of 1999. The first commercial 3G network was launched by NTT DoCoMo in Japan branded FOMA, based on W-CDMA technology on October 1, 2001 [1].

A. *Frequency Bands*

WCDMA is globalised technology Designed for 1900 MHz To provide integrated high quality audio and video data, high speed data rate, video conferencing and other multimedia services. WCDMA frequency ranges for FDD (frequency Division Duplex) & for TDD (time Division duplex)

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Bandwidth =60. 5MHz bandwidth assigned to operator while the operator are utilizing 3.84 MHz only [8].

frequency band only.

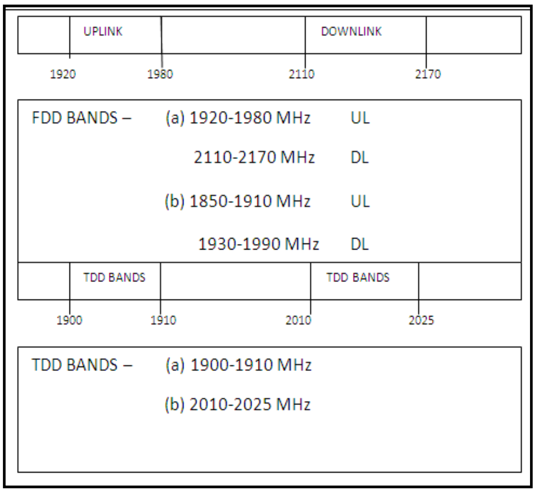

Fig-9 *(UMTS frequency Bands)*

A. Handover

All WCDMA network provider were want to minimize their infrastructure cost so they utilize their 2G infrastructure and sharing sites with other network provider. The network coverage, capacity and quality information will be overlaid on the actual handovers that are executed during the drive tests. Handover is being performed only on the basis of network designed parameter and planning of RF team. Third generation is upgraded version of GSM technology and operated two kind of handovers.

- Intra-System
  Intra-frequency handovers -Soft, Softer
  Inter-frequency handovers –Hard
- Inter-System handovers
  Handover between WCDMA <> GSM (Hard),
  Handover between WCDMA/FDD <> TDD (Hard)[8].

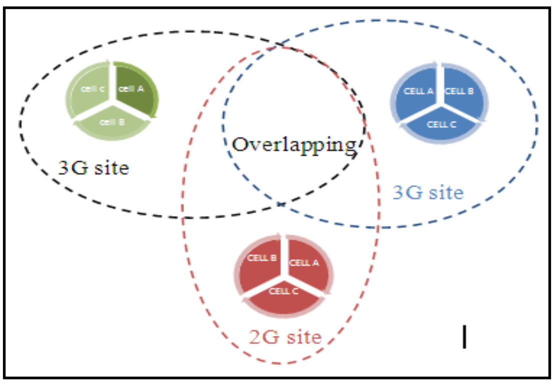

FIg-10 (*3G Handover Concept*)

B. UMTS Architecture

The main components include BSS (BSC, BTS), RNS (Node B, Radio Network Controller), and WMSC

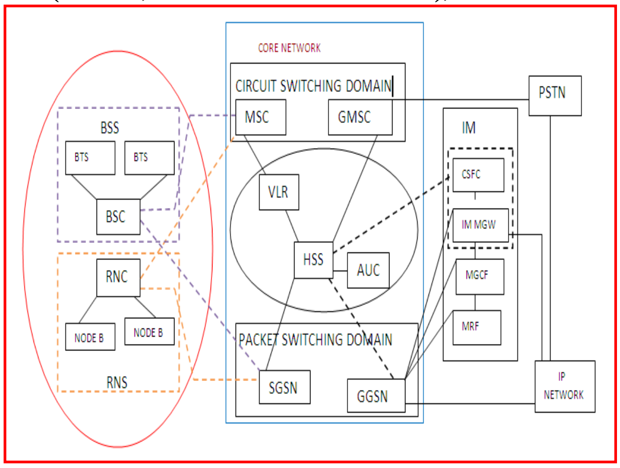

Fig-11 *(UMTS Architecture)*

(Wideband CDMA Mobile Switching Centre) SGSN / GGSN and PSTN Architecture and working of UMTS are explained in the given Diagram [6].

C. Channel Access Duplex Methods-

- *Time Division Duplex*

  Time division duplex (TDD) is the application of time-division multiple access to separate forwarding and returning signals. Time division duplex has a strong advantage in case asymmetry of the uplink and downlink data speed. While uplink data increases, more bandwidth can be allocated to that and as it shrinks bandwidth taken away. While uplink and downlink radio paths are similar in case of a slow moving system beam forming technique works well with TDD systems [7, 13].

- *Frequency Division Duplex-*

Frequency division duplex (FDD) is the application of frequency-division multiple access to separate transmitting and receiving signals. The uplink and downlink sub-bands separated by the "frequency offset". In case symmetric traffic FDD gives good performance. In this case TDD tends to waste bandwidth during switchover from transmitter to receiver, has greater inherent latency, and may require more complex, more power-hungry circuitry. FDD makes radio planning easier and more efficient and avoid interference *[7, 13]*.

- *Spread Spectrum Techniques-*

There are two major types of spread spectrum techniques Direct Sequence Spread spectrum and Frequency hoping spread Spectrum. CDMA is a multiple-access scheme based on spread-spectrum communication

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techniques it spreads the message signal to a relatively wide bandwidth by using a unique code that reduces interference and enhances System processing. CDMA does not require frequency or time division for multiplexing and improves the capacity of the communication system. The PN signal (pseudorandom noise) can amplitude modulate the message waveform to generate direct-sequence spreading, or it can shift the carrier frequency of the message signal to produce frequency-hopped spreading. The direct-sequence spread-spectrum signal is generated by multiplying the message signal d(t) by a pseudorandom noise signal pn (t) g(t) = pn(t)d(t) [15].

D. UMTS Channels

- Logical Channel between RLC and MAC layer
- Transport channel between MAC and PHYSICAL layer
- Physical Channel [7]

E. Antenna

Antenna azimuth, Antenna height, Antenna type are necessary parameter for proper network tuning. In UMTS directional antenna (60, 90, 120 degree) are being used which is responsible for filling coverage gap, proper site handover, link connectivity, both electrical and mechanical down lilt is used for proper coverage in UMTS[5].

G. UMTS Optimization

To analysis the UMTS performance we use following Drive test performance parameters UARFCN (UMTS Absolute Radio Frequency Channel Number) ,CPICH_RSCP (Receive Signal Code Power) (good > -85dBm),RSSI(Receive Signal Strength Indicator),SC (Scrambling Code) , CPICH_ Ec/No (> -8 dB) ,UE ,Drop call rate(DCR),call setup success rate(CSSR),Tx Radio Parameters(Tx Power, UTRA carrier RSSI, Target SIR, SIR, SQI MOS 4.05,RCC State , MODE always WCDMA/GSM) [8,14].

F. UMTS Services

UMTS Services include wide-area wireless voice telephony, video calls and broadband wireless data, all in a mobile environment. Additional features also include HSPA (High Speed Packet Access) data transmission capabilities able to deliver speeds up to 14.4 Mbps on the downlink and 5.8 Mbps on the uplink and offer 384 Kbps- pedestrians standing or moving slowly in the cluster. UMTS Data are sent through packet switching , Voice calls are interpreted using circuit switching ,Access to Global Roaming Clarity in voice calls, Fast Communication, Internet, Mobile T.V, Video Conferencing, Video Calls, Multi Media Messaging Service (MMS), 3D gaming and other Multi-media application etc are also available with 3G phones and Transmission speed from 144 kbps to 2 Mbps .

VI. LTE TECHNOLOGY (4G -2010)

In Telecommunications, 4G is the forth generation of cellular wireless standards, it is Successor to the GSM and UMTA Standards. In 2008 The ITU-R organization Specified the IMT Advances (Inter National Mobile Telecommunications Advanced) Requirement for 4G standard services at 100Mbit/s for high mobility vehicle (cars trains) And 1Gbps for pedestrian and low mobility vehicle. 4G architecture includes three basic areas of connectivity; PANs (such as Bluetooth), WAN (such as IEEE 802.11), and cellular connectivity. Under this umbrella, 4G will provide enlarge no of internet application accessing mobile devices any where any time in the particular cluster. Every subscriber is able to communicate with Internet-based information. The world's first publicly available LTE service was launched by Telia Sonera in Oslo and Stockholm on December 14 2009. In 2011, LTE services was launched in North America with the Samsung Galaxy on February 10, 2011, HTC Thunder Bolt starting on March 17 being the second LTE smart phone to be sold commercially. In Canada, Rogers Wireless was the first to launch LTE network on July 7, 2011 offering the Sierra Wireless Air Card 313U USB mobile broadband modem [6].

A. Frequency Bands

The LTE standard can be used with many different frequency bands. In North America, 700/800 and 1700/1900 MHz are used; 2500 MHz in South America; 800, 900, 1800, 2600 MHz in Europe; 1800 and2600 MHz in Asia; and 1800 MHz in Australia As a result, phones from one country may not work in other countries. Users will need a multi-band capable phone for roaming internationally [6].A key aspect of LTE specifications is the enhancement of Multimedia Broadcast/Multicast Services (MBMS), where compressed data is transmitted to multiple users and multiple locations in a specific service cluster. Lte technology support high speed mobility up to 350 km/h hence it is using high frequency band 2GHz to 8 GHZ [2].LTE support global roaming so in various part of world it launched on 2100MHz (India) frequency band. In cities and urban areas higher frequency band such as 2.6GHz (EU) are used to support high speed mobile broad band With 60 MHz bandwidth and 190 Duplex spacing.

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FDD-

UPLINK - 1920-1980 MHz } for 2100MHz

DOWNLINK - 2110-2170 MHz

TDD- } for 2100MHz

UPLINK - 1900-1920 MHz
DOWNLINK - 2010-2025 MHz

Typically, a telecom operator will be allowed to operate an LTE network in a certain band and its bandwidth will be allocated in terms of Resource Blocks (RBs) LTE BANDWIDTH

TABLE-2

Channel Bandwidth ,MHz	1.4	3	5	10	15	20
Number of resource blok	6	15	25	50	75	100

[13].

B. LTE Handover

HANDOVER is the key of successes of any wireless networks. In the development of 4G technologies the primary goal to researcher was to provide fast and seamless handover from one serving source cell to another serving target cell for every wireless serving network (GSM, UMTS) .LTE using *forward Handover*, *backward handover*, *Radio Link Failure (RLF) handover*. Forward handover improves the overall handover performance in LTE systems. [18]. *Forward handover* is successful even if the radio conditions are not good enough for the message exchanges between the UE and network in the current Release 8 framework. Forward handover Provide robust mobility .Forward Handover is also cost attractive in an evolving network topology, while new nodes can be added on an ad-hoc basis in hot-spots without the need for extensive *drive tests* to recomputed optimal RLF timers. In the context of *backward and RLF Handover* the handover procedures require the source eNB to prepare a target cell for handover concurrently with the handover decision otherwise , the UE transitions to idle-state where it attempts to complete the handover procedure by transitioning back to connected-state via a procedure called *Non-Access Stratum (NAS) recovery*. The target cell may belong to either the source eNB (intra- eNB handover) or a target eNB (inter - eNB handover) Handovers in LTE are 'hard' handovers, meaning that there is a short interruption in service when the handover is performed.RLF HANDOVER is UE-based mobility and provides a recovery mechanism when the backward handover Signaling with the source cell *partially* fails due to poor radio conditions. Specifically, the radio conditions are good enough for the source eNB to be able to decode the Measurement Report from the UE and subsequently prepare the target cell for handover, but not good enough for the UE to be able to decode the Handover Command from the source eNB [17].

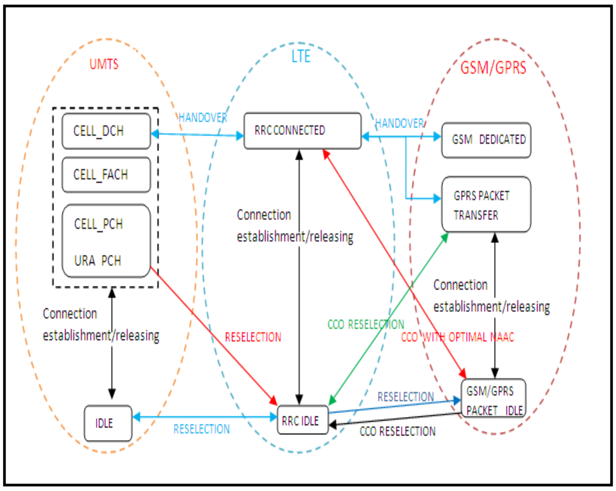

Fig-12 *(LTE handover)*

C. LTE Architecture

In parallel with the LTE radio access, packet core networks are also evolving to the flat SAE architecture. This new architecture is designed to optimize network performance, improve cost-efficiency and facilitate the uptake of mass-market IP based services .There are only two nodes in the SAE architecture user plane: the LTE base station (eNodeB) and the SAE Gateway. The LTE base stations are connected to the Core Network using the Core Network–RAN interface, S1. This flat architecture reduces the number of involved nodes in the connections. Existing 3GPP (GSM and WCDMA/HSPA) and 3GPP2 (CDMA2000 1xRTT, EV-DO) systems are integrated to the evolved system through standardized interfaces providing optimized mobility with LTE. For 3GPP systems this means a signaling interface between the SGSN and the evolved core network and for 3GPP2 a signaling interface between CDMA RAN and evolved core network. Such integration will support both dual and single radio handover, allowing for flexible migration to LTE.

D. LTE Channels

Lte used three kinds of channels, logical (This data can be either control or user data.) channel, transport channel (Transport Channels define how and with which characteristics data is transferred by the physical layer.), physical channel (Physical Channels define the exact physical characteristics of the radio channel).

TRANSPORT CHANNELS Downlink: BCH, PCH, MCH, DL-SCH	PHYSICAL LAYER USE- -PHYSICAL CHANNEL AND

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LOGICAL CHANNELS-

Control channels:
Downlink: BCCH, PCCH, MCCH
Bidirectional: CCCH, DCCH
Traffic channels:
- Downlink: MTCH
- Bidirectional: DTCH

[19].

E. Channel Access Method

LTE uses OFDM for the downlink – that is, from the base station to the terminal. OFDM meets the LTE requirement for spectrum flexibility and enables cost-efficient solutions for very wide carriers with high peak rates. It is a well-established technology. The OFDM symbols are grouped into resource blocks. The resource blocks have a total size of 180 kHz in the frequency domain and 0.5ms in the time domain. Each 1ms Transmission Time Interval (TTI) consists of two slots (T slot).In the uplink, LTE uses a pre-coded version of OFDM called Single Carrier Frequency Division Multiple Access (SC-FDMA). This is to compensate for a drawback with normal OFDM, which has a very high Peak to Average Power Ratio (PAPR). High PAPR requires expensive and inefficient power amplifiers with high requirements on linearity, which increases the cost of the terminal and drains the battery faster. SC-FDMA solves this problem by grouping together the resource blocks in such a way that reduces the need for linearity, and so power consumption, in the power amplifier. A low PAPR also improves coverage and the cell-edge performance [16].

F. Antenna

In Lte new advanced antenna is used in provide proper handover with different operating technology. These antennas have high capabilities to fill coverage holes [5]. Solutions incorporating multiple antennas meet next-generation mobile broadband network requirements for high peak data rates, extended coverage and high capacity. Advanced multi-antenna solutions are key components to achieve these targets. There is not one antenna solution that addresses every scenario. Consequently, a family of antenna solutions is available for specific deployment scenarios. For instance, high peak data rates can be achieved with multi-layer antenna solution such as 2x2 or 4x4 Multiple Input Multiple Output (MIMO) whereas extended coverage can be achieved with beam-forming [16]**.** As shown in the diagram (14) Lte is getting and releasing handover to GSM, LTE and other future upcoming technology.

G. LTE Services and Optimization

4G networks reliable wireless services but also provides huge of services within a secure operational environment .The services shown in given diagram 4G networks making them available to everyone, anytime and everywhere.

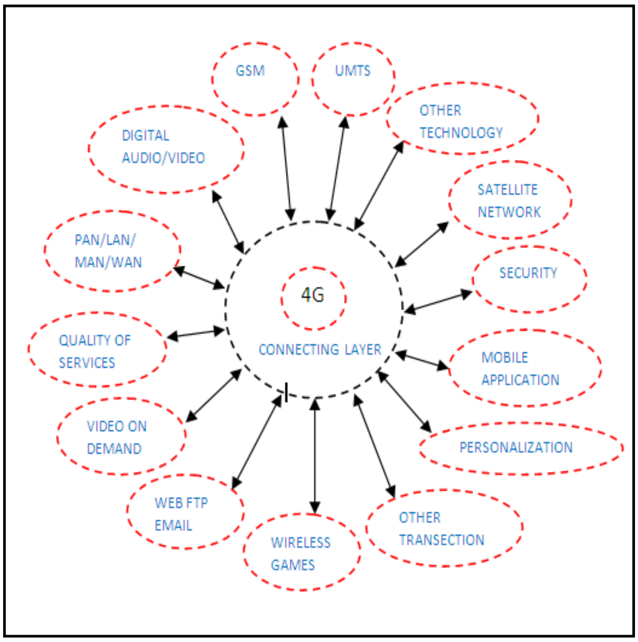

Fig-13 (*LTE services*)

The Lte Network is specially designed for high uplink and downlink data rates with mobility .Peak data rate of 1 Gbps for downlink (DL) and 500 Mbps for uplink (UL) [20].following are the measure performance parameter of LTE RRC and NAS protocol log, Cell-E-ARFCN,RSRP,RSRQ,SINR/CINR,DL-SCH/UL-SCH Throughput, DL-SCH/UL-SCH BLER, DL RB ULRB,DL MCS UL MCS, Wide hand / Narrow band CQI, Rank , UE TX power ,Application Throughput , ping test[21].

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