

* Evolution of wireless communication system

wireless communication took a new height and revolutionized the field of communication after Bell Laboratories developed the cellular concept in year 1960's and 1970's.

Before that wireless communication was started or initiated from

1678 : Huygen work for phenomenon of light reflection & refraction .

1819 : Fresnel demonstrates the wavelike nature of light

1831 : Faraday demonstrates electromagnetic induction field, wave equations.

1886 : H. Hertz demonstrates experimentally the transmission and detection of Electromagnetic (E.M) wave between two points a few meter apart.

1896 : Marconi "long waves" demonstrating communication over 3 km .

1898 - 1901 (Guglielmo Marconi)

wireless Telegraphy (Morse code), Longwave transmission (trans atlantic) at an operating frequency of 1 MHz .

1906 - 1st

World Radio Conference

- 1907 - Commercial Transatlantic Connection.
Huge Base stations (20 to 100m high Antennas)
- 1915 - Wireless voice transmission from Newyork to San Francisco
- 1920 - Shortwaves by Marconi, Reflection at ionosphere
- 1925 - Frequency Modulation (F.M) E.H. Armstrong
- 1946 - Mobile Telephone Service (MTS) in U.S.
Based on F.M Technology
- 1958 - A-Netz in Germany at 160 MHz
Analog cellular connection
- 1972 - B-Netz in Germany at 160 MHz.
- 1979 - Analog Mobile phone system (AMPS) in U.S at 850MHz
Nordic Mobile Telephony (NMT) at 900MHz in Scandinavian countries
- 1985 - France Radiocom 2000 at 400MHz
UIC's Total Access Communication System (TACS) at 935 MHz
- 1986 - C-Netz in Germany at 450 MHz.
- 1991 - Digital Enhanced cordless Telecommunication (DECT) user 10000/km²
- 1992 - Start of Global System for Mobile Communication (GSM), Fully Digital, 900MHz
- 1994 - GSM at 1800Hz
- 1996 - High performance Radio Local Area Network (HiPER LAN)
5GHz and 11GHz, wireless ATM
- 1997 - wireless LAN IEEE-standard 2.4-2.5GHz

- 1998 - Universal Mobile Telecommunication System (UMTS) specification for Next Generation CDMA
QualComm starts work on wideband CDMA.
- 1999 - Specification of IEEE 802.11b (Wireless LAN)
Increased B/w to 11 Mbps
- 2000 - Bluetooth specification
1 Mbps specification completed
10 Mbps is initiated

* Generation of Mobile Network or Modern wireless Communication System

3G Third Generation

Continues International Telecommunication Union (ITU) Standardized 3G as (IMT-2000) International Mobile Telecommunication -2000.

3G Network offers wide range of services with greater network capacity and improved spectral efficiency. 3G Network provides

- a) High data rate: 144 Kbps in all environment and 2 Mbps in low-mobility and indoor environments.
- b) Circuit & packet switched based services.
- c) Supports multimedia services.
- d) seamless incorporation of 2G cellular system.
- e) Global roaming & open architecture for rapid introduction of new services and technology.

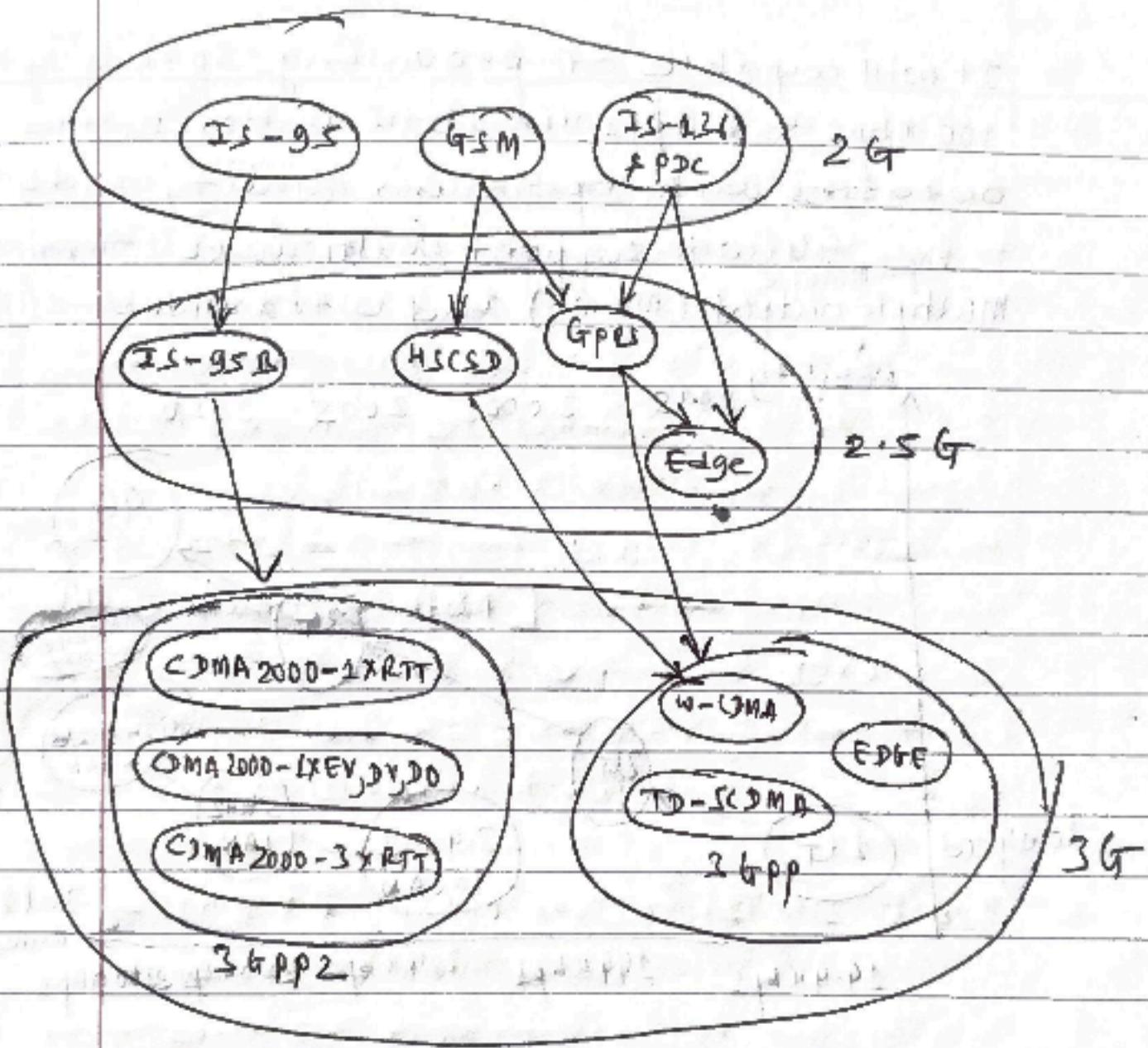


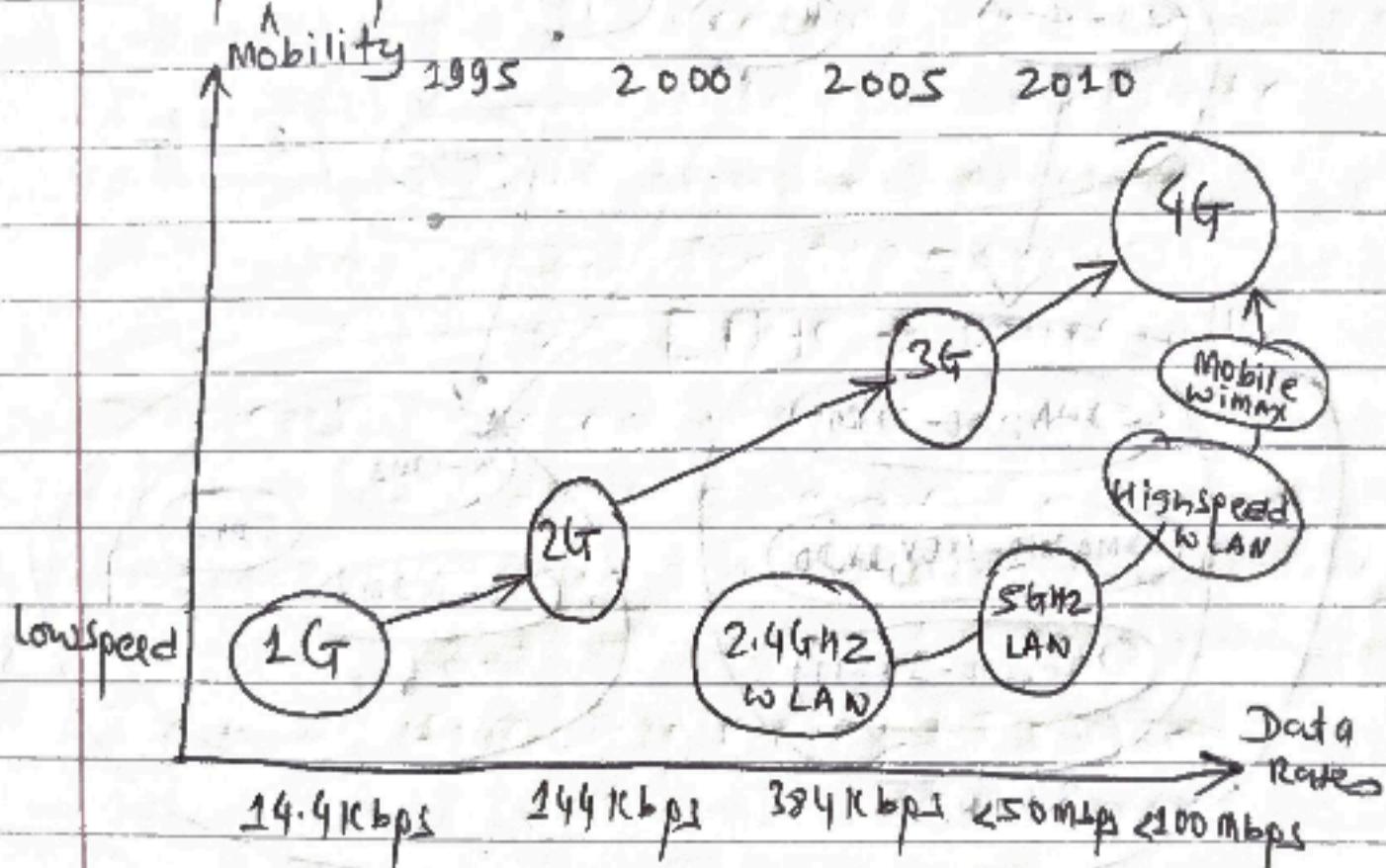
fig: → Various Upgrade path from 2G to 3G

* 4G Fourth Generation

4G (Fourth Generation) represents the next complete evolution in wireless communication. 4G system will be able to provide a comprehensive IP solution where voice, data and ^{services} multimedia are provided at higher data rates ever to the user.

It will capable of providing speeds upto 100 Mbps to 2 Gbps for both indoors and outdoors with optimum quality and security.

4G will support Multicarrier communication, Input multiple multiple output (MIMO) and ultra wideband (UWB).



Technology Migration from 1G to 4G.

1-2 Simplex and Duplex Communication : TDD & FDD, Radio Frequency Spectrum

* Simplex :

In simplex system, communication is ~~done~~ in one directional only. eg: → Broadcasting system, pager (paging system)

There is no mechanism to send back error or control signal to the transmitter.

2) Half Duplex:→

Half Duplex Radio system allows two way communication one at a time. They use same radio channel for both transmission and receive. Therefore user can transmit or receive information at a time. Eg:→ Walkie-Talkie.

3) Full Duplex:→

Full Duplex Communication transmits and receives information at a same time & provides two simultaneous but separate channel [Frequency Division Duplexing(FDD)] for Communication or Time Division Duplexing (TDD) different time slots on single radio channel for communication between users. eg:→ Telephone System, Mobile System.

* Frequency Division Duplexing (FDD):→

Frequency Division Duplexing (FDD) supports radio communication by using

two distinct channel. FDD is based on transmitting and receiving signal from one another at a same time.

At base station separate transmitting and receiving Antennas are used to accommodate two separate channel but at subscriber unit, single Antenna is used for transmission and reception. [Note: \rightarrow Device called Duplexer is used inside subscriber unit to enable the same Antenna for simultaneous transmission and receive]

* Time Division Duplexing (TDD) : \rightarrow

Time Division Duplexing is defined as the transmission of information in both way using single frequency at different Time slot.

It is the technique or way to share single radio channel by time, so that portion of time is used to transmit from base station to the mobile and the remaining time to transmit from mobile to base station.

Time Division Duplexing

is best suited for bursty traffic, such as Internet or data centric services (YouTube).

TDD is possible for digital transmission format and digital modulation.

* Radio Frequency Spectrum

Frequency Name Uses

3-30 kHz	VLF	Navigation, Submarines Comm ⁿ
30-300 kHz	LF	Navigation, RFID, Amateur Radio
300-3000 kHz	MF	AM (Medium-wave) Broadcast
3-30 MHz	HF	Shortwave Broadcast, Aviation, Marine & mobile Radio Telephony
30-300 MHz	VHF	FM, Television Broadcast, Aviation, Mobile Communication
300-3000 MHz	UHF	Television Broadcast, Microwave Communication, Mobile phone, Wireless, LAN, GPS
3-30 GHz	SHF	Microwave, Radar, Satellite Comm ⁿ

1.3 Conventional Mobile Radio versus Cellular Mobile Radio, cellular Mobile versus wireless in Local Loop (WLL), Features of cellular radio, Digital cellular radio.

* Conventional Mobile Radio

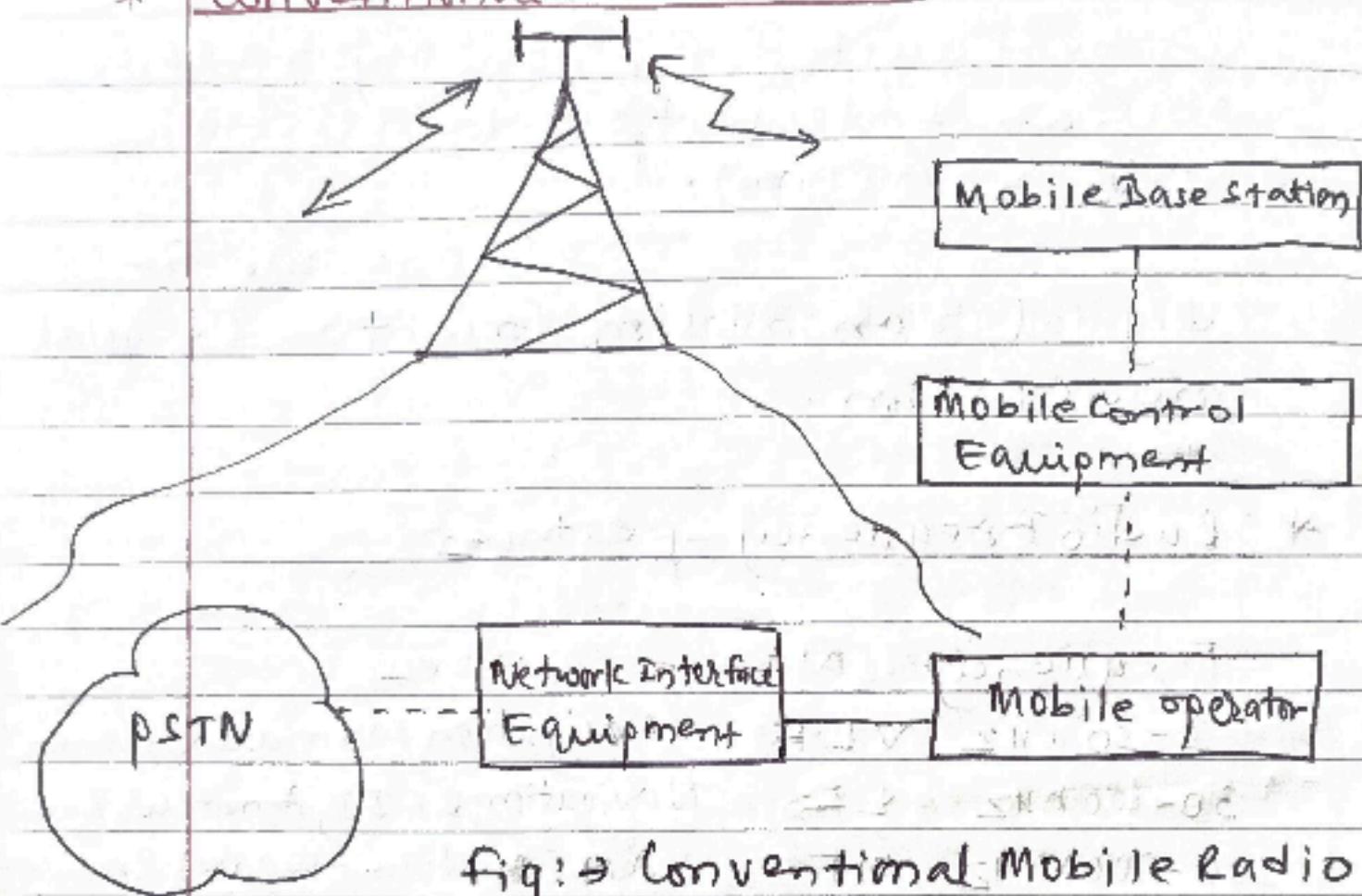


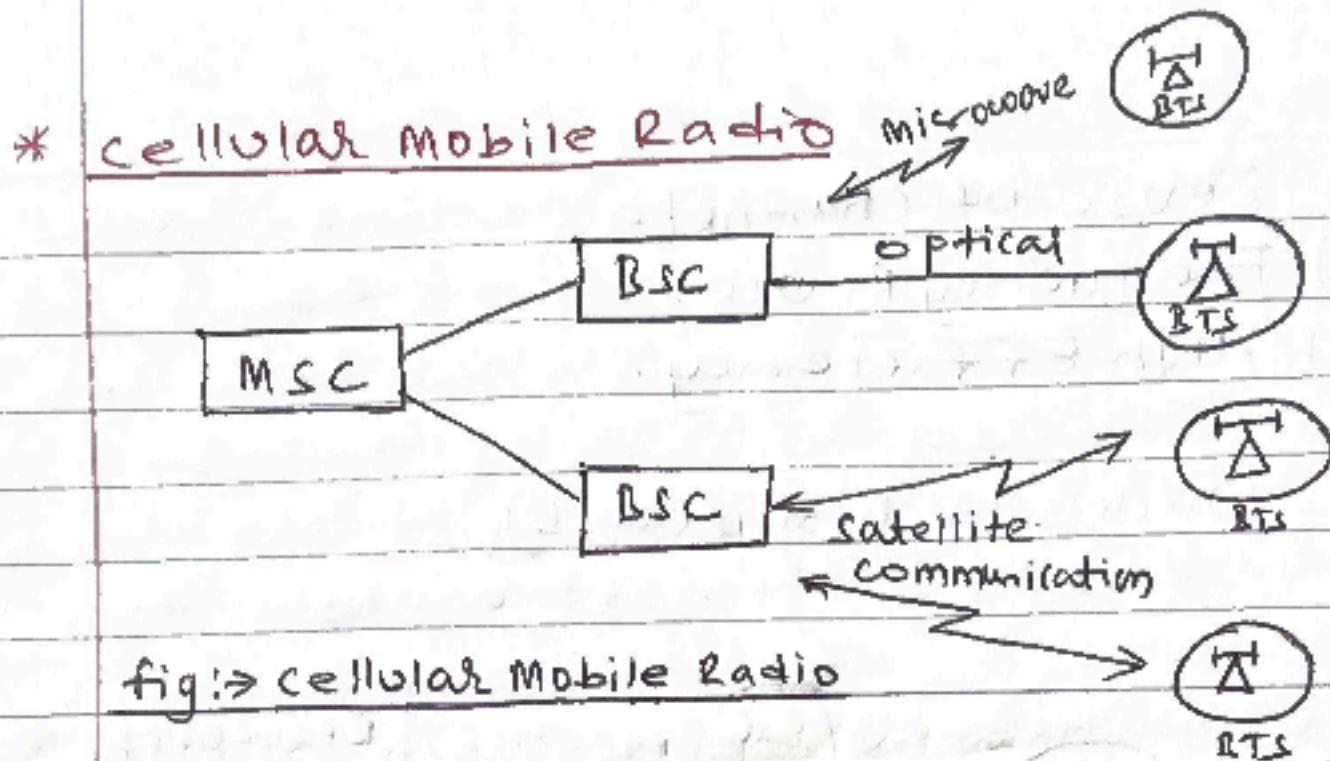
fig: → Conventional Mobile Radio

Conventional Mobile Radio was based on mounting high powered transmitter at hill top. It was designed to achieve maximum coverage area.

Conventional Mobile Radio had many limitations. They are

- 1) Limited user
- 2) limited service capability
- 3) poor service performance

Bell Mobile System in New York City in year 1970's supported 12 simultaneous call over 100 square miles.



cellular Mobile Radio overcomes the limitation of the Conventional Mobile Radio. cellular Mobile Radio is based on cellular concept. A single high powered transmitter (Tx) [Large cell] is replaced with many low power transmitter (small cell) covering small region of service area. cellular Mobile Radio is best on every aspect with regards to conventional Mobile Radio.

Advantages of cellular Mobile Radio over Conventional Mobile Radio are

- 1) powerful transmitter located at the highest spot were replaced by many low power transmitter.
- 2) Increase in System Capacity.

The radio or wireless signals are used for connection between Base station and Residence, office building, Government Agency.

* cellular Mobile versus wireless local loop (WLL)

wireless,local,Loop	cellular Mobile
1) Mobility is limited	1) Full Mobility
2) WLL has one Handover concept	2) cellular Mobile is based on Handover concept
3) No Frequency Reuse concept	3) Based on Frequency Reuse concept
4) Fixed Terminal	4) provides Roaming Facility
5) Cost is fixed	5) Adds additional charge for services

* Digital Cellular Radio

Digital cellular radio technology is based on the combination of digital signal processing and cellular

radio technology. It offers

1. Increased capacity and security.
2. Reduced number of towers.
3. Increased number of available channel.
4. High speed packet data.
5. Supports simultaneous multimedia service.
6. High bandwidth.
7. Improved Noise Immunity.
8. Encrypted voice and data.
9. TDMA/CDMA based technology.
10. Best Quality of Service (QoS) than existing.

First Generation (1G) Technology is based on FDMA/2 FDD
g analog FM having operating frequency band 450 MHz to 1 GHz.

* Generation of Mobile Networks

1) First Generation (1G) : →

In late 1970's and early year the first mobile networks in 1980's were analog modulation system such as AMPS (Advanced mobile phone system). The first generation network were planned to achieve maximum coverage with few antennas as possible. It had several large cell to cover large areas. It consists of omnidirectional antennas and is circuit switched. First Generation N/Ws supported voice only. Data services and SMS was not supported by the technology.

Total Access Communication System (TACS)-UK

- * problems Nordic Mobile Telephone (NMT) System - Scandinavia
 - 1) Limited capacity C-Netz 450 (450) System - Germany
 - 2) Bulky Equipment Nippon Telephone & Telegraph (NTT) System
 - 3) Lack of security
 - 4) Incompatible System
 - 5) Poor Quality
- 2) Second Generation (2G) : →

First Generation networks had limited subscribers and had inherent problems. Second Generation Cellular Network was Digital modulation system which was named as GSM system in Europe. It was introduced in early 1990's.

It's operating band of freq "n" is between 900 MHz and 1.9 GHz
gt developed the concept to include multilayer cellular patterns which used available frequencies (spectrum) to provide better

- a) Coverage : \rightarrow Getting a usable radio signal to all areas in the network
- b) Capacity : \rightarrow Handling the call traffic.
- c) Quality : \rightarrow Low interference, few calls are dropped etc .

gt provides wireless data services such as Internet access with speed of 14.4 kbps and the technology is based on TDMA/FDD & CDMA/FDD.

3) 2.5 Generation (2.5G) : \rightarrow (GPRS)

gt supports e-mail traffic and is locationbased mobile service.

wireless application

high speed switching data (HSCSD) supporting higher data rate transmission for web browsing.

gt is so called

GSM/GPRS technology which stands for General Packet Radio Service . gt is a

data oriented technology extending GSM

Voice services . gt uses packet switching protocol (WAP), for data and has speed for 145 kbps.

(CDMA2000). It has increased throughput rates