Evolution of Mobile Communication

1G (FIRST GENERATION MOBILE SYSTEM):

- 1G was introduced in 1980 and completed in 1990.
- The first generation of wireless telephony technology was referred to as 1G.
- The speed of 1G was 2.4 kbps telecommunications.
- It allowed the voice call in one country.
- Analog Signal and AMPS was used.
- It was first launched in USA in 1G mobile system.

Technologies under 1G

- As early cellular phone technology worked in 150 MHz of frequency band. Telephone Systems (AMTS), Push to Talk (PTT) and Improved Mobile Telephone Service (IMTS) are the technologies under 1G.

Features of 1G

- In voice call and text messages is available by use of analog narrow bandwidth.

Drawbacks in 1G

- Analog cellular phones are not very protected.
- It has a limited capacity, poor battery life, poor large phone size, poor handoff reliability, poor voice quality, and no security at all since voice call can be hacked by radio towers.

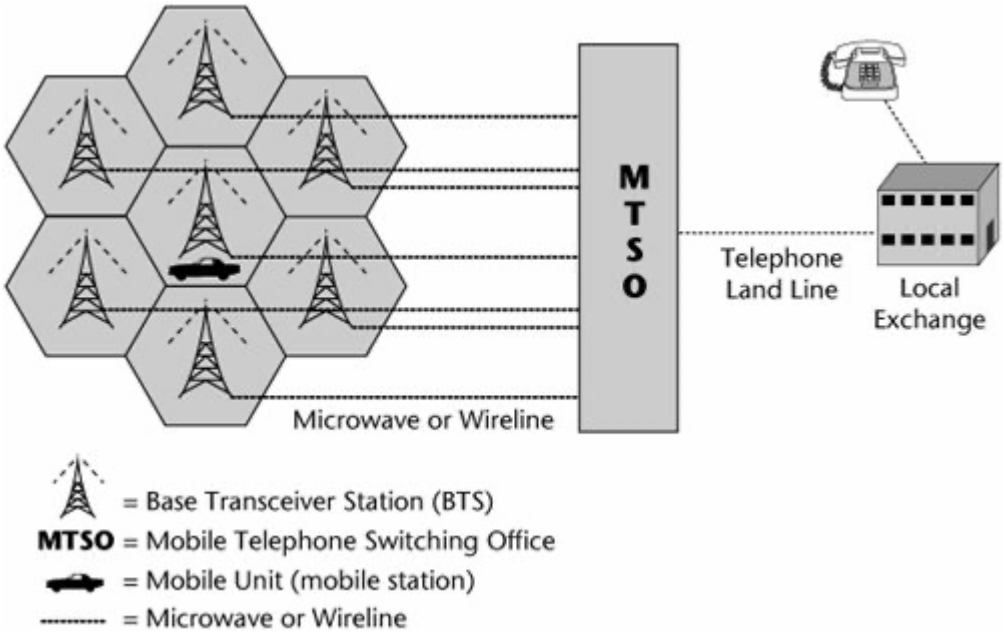


Figure.1 1G Architecture.

2G (SECOND GENERATION MOBILE SYSTEM):

- 2G refers as the 2nd generation which is based on the **GSM**.
- In 1991, 2G was first launched in Finland
- Digital modulation signal was used in 2G.
- Its data speed is 14kbps to 64kbps.

Technologies under 2G

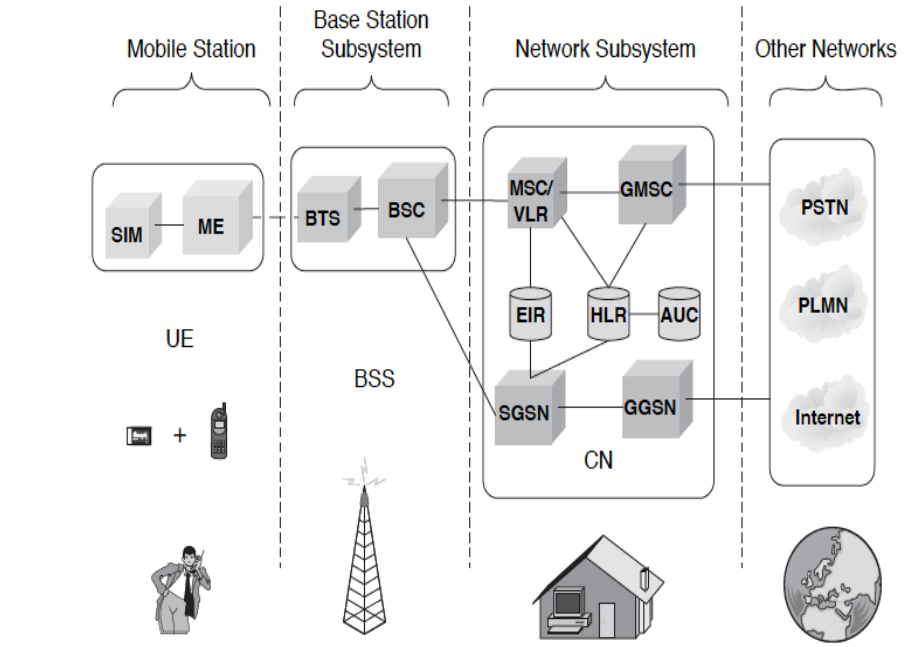
- Personal Digital Com, Code Division Multiple Access (CDMA), Global System for Mobile Communication (GSM), Multiple Digital Systems, Time Division Multiple Access, General Packet Radio Service (GPRS), and Enhanced Data Rates for GSM Evolution (EDGE) are the Mobile technologies comprised in 2G.

Features Include in 2G

- It includes Digital Text messages, picture messages and MMS. It provides better quality and capacity and consumes less battery power, improves the voice clarity, reduces noise in the line, and gives security and safety to the data and voice calls. Digital error checking allowed by digital voice encoding to increase sound quality and lowers the noise level.

Drawbacks in 2G

- 2G needs strong digital signals. If there is a refusal of network coverage in any specific area, digital signals would weak.
- Complex data such as Videos are unable to handle.
- It has a Jagged Decay curve such as Abrupt dropped calls and Analog – gradual sound reduction. It has a low transmission
- Quality, and Spotty Coverage.



SGSN: Serving GPRS Support Node
GGSN: Gateway GPRS Support Node
HLR: Home Location Register
VLR: Visitor Location Register
MSC: Mobile Switching Center
BSS: Base Station System
GMSC: Gateway MSC
EIR: Equipment Identity Register
ME: Mobile Equipment
SIM: Subscriber Identity Card
PLMN: Public Land Mobile Network

Figure.2 2G system.

3G (THIRD GENERATION MOBILE SYSTEM):

- 3G system goal is to increase the data rates.
- In 2000s 3g technology was introduced.
- The speed of data transmission is 384kbps- 2Mbps.
- To provide accommodation web-based applications and audio and video files Smart Phones and its characteristics increased its bandwidth and data transfer rates.
- It consists of large capacity and broadband capabilities.
- It increases the spectrum efficiency of 5MHz.
- It works under Multiplexing and Access technologies.

Technology under 3G

- WCDMA (Wideband Code Division Multiple Access)
- CDMA2000 1X can support voice and data services.
- The maximum data rate can reach 153 kbps, belonging to 3G mobile communications.

Features Include in 3G

- Faster Communication is provided in 3G.
- To Send/Receive the large Email messages faster and have a High Speed Web / More Security.
- It consists of Video Conferencing / 3D Gaming, Mobile, TV, Phone Calls, Large Capacities and Broadband
- Capabilities moreover 11 sec – 1.5 min and time to download a 3 min Mp3 song.
- It provide a service of Wireless voice telephony, fixed wireless Internet access, Location-based services, Telemedicine, high speed internet access, Web browsing, email, paging, fax and navigational maps. The traffic and weather updates, Mobile office services, like virtual banking.
- It has a higher security features than 2G like User Domain, Application Security, Network Access and Domain Security can be restricted.

Drawbacks in 3G

- It has overpriced fees for 3G Licenses Services**.** To build the infrastructure for 3G was challenged and need a Large Cell Phones**.**
- High Bandwidth Requirement and also works in Expensive 3G Phones.

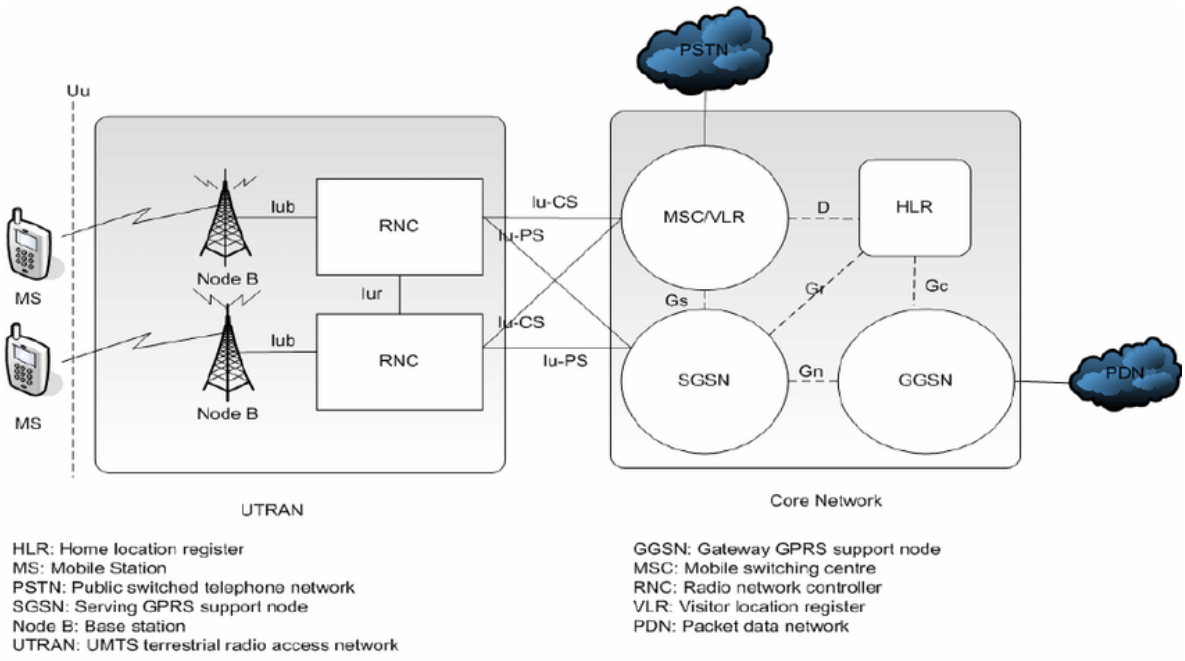


Figure.3 3G UMTS Architecture.

4G (FOURTH GENERATION MOBILE SYSTEM):

- It was started as late 2000.
- An IP-based incorporated system which has a capacity to afford 100 Mbps for high mobility and 1Gbps for low mobility with end toned Quality of service and gives an authentication process and it offers the various services as user requirements, anywhere that extends to which system and devices can exchange and interpret the data.
- A compilation of technologies to generate fully packet-switched networks optimized for data is 4G.

Technology under 4G

- Progressed UMTS Terrestrial Radio Access (E-UTRA) and new packet – switching based core network called as Evolved Packet.
- The flawless handovers for data and voice to GSM, UMTS or CDMA2000 technology allowed by IP based architecture.
- Personal Layer Gateway contains devices that connect to upper layers, voice, data modem, cell phone, fax, PDAs and MP3 players.
- Info-Sensor layer is contains environmental sensors. Fiber-optic wire layer has high speed unfathomable tangle of fiber optic wires and repeaters.

- Ad Hoc Networks has a Spontaneous self-organization of networks of devices and do not have any necessarily connected to internet.
- It consists of TDMA design, Soft Handoff, CDMA design, RAKE receiver, Handoff, Power Control, Traffic engineering, paging.

Features Include in 4G

- 4G has a wireless broadband access, video chat, Digital Video Broadcasting (DVB), least services like voice and data, mobile TV, Multimedia Messaging Service (MMS) HDTV content, and other services that make use of bandwidth.
- It also consists of High Speed, High Capacity and Low-Cost Per-bit etc. It is Capable to provide speed 100Mbps-1Gbps.
- It contains High QOS and High Security.
- As per the user requirements, any kind of service can be provided.

Drawbacks in 4G

- 4G is very hard to implement. It does need complicated hardware. The Battery uses of 4G are more and Expensive equipment
- required to implement next generation network.

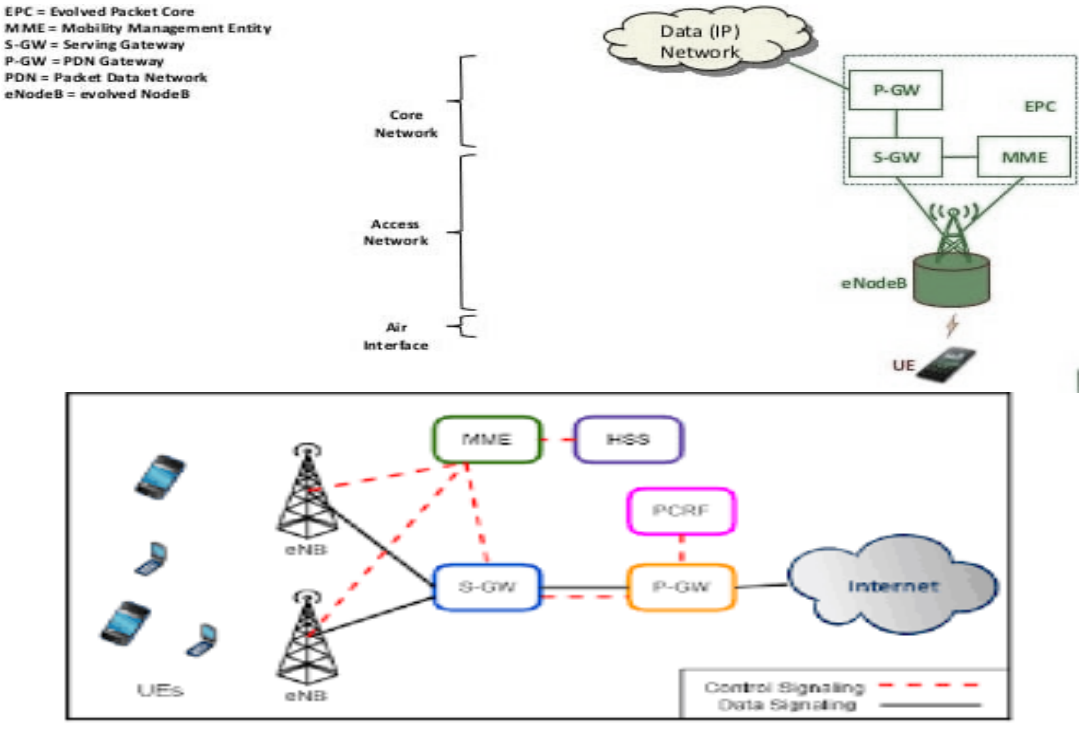


Figure.4 4G LTE Components and Architecture.

5G (FIFTH GENERATION MOBILE SYSTEM):

- The initiation year of 5G is late 2010's.
- The new mobile revolution is happen in mobile market is 5G.
- It is wireless and does not have any limitations.
- WWWW (Wireless World Wide Web) is highly supportable.
- The Physical and Data Link layer indicates an Open Wireless Architecture (OWA).
- Virtual multi-wireless network can be maintained.
- The Network layer is classified into two layers that are the upper network layer is for mobile terminal and lower network layer is for interface. In routing each one IP addresses which would be different in each one of IP network worldwide.
- Open Transport Protocol (OTP) overcomes a higher bit rate.
- Transport and Session layer is supported by it.

Technology under 5G

- 5G Technology has Millimeter-Wave technologies which is using frequencies much higher in the frequency spectrum releases more spectrums and also gives the chance of having much wide channel bandwidth probably 1 - 2 and frequencies of beyond 50GHz are being used.
- A number of other high data rate systems as well as in waveform, OFDM has been utilized very effectively in 4G LTE.
- Generalized Frequency Division Multiplexing, Universal Filtered Multicarrier and Filter Bank Multi- Carrier were included in the configuration.
- Schemes has a techniques include NOMA, PDMA, OFDMA, SCMA, MUSA and IDMA.
- Techniques help to deployed as femtocells can operate satisfactorily and also ensure that small cells in the macro-network.
- It also consists of, Cognitive radio technology, Pervasive networks, Group cooperative relay Wireless mesh networking and dynamic ad-hoc networking and Smart antennas.

Features Include in 5G

- The real time performance has Fast response, Low Jitter, latency & delay.
- It provides large broadcasting of data in Gbps and high quality coverage.
- The Virtualized Infrastructure has Software defined network, scalable and low cost system.
- It supports IoT & M2M and also enormous amount of connected devices, Deep Indoor Coverage & Signaling efficiency.

- As per the connected network and geographical position, it assigned the Mobile IP address.
- Higher altitude Radio signal knowing weather and location while talking by use of Parallel multiple services.
- A great feature is Remote diagnostics.

Drawbacks in 5G

- To develop an infrastructure is very expensive.
- There are some issues occur in privacy and Security.

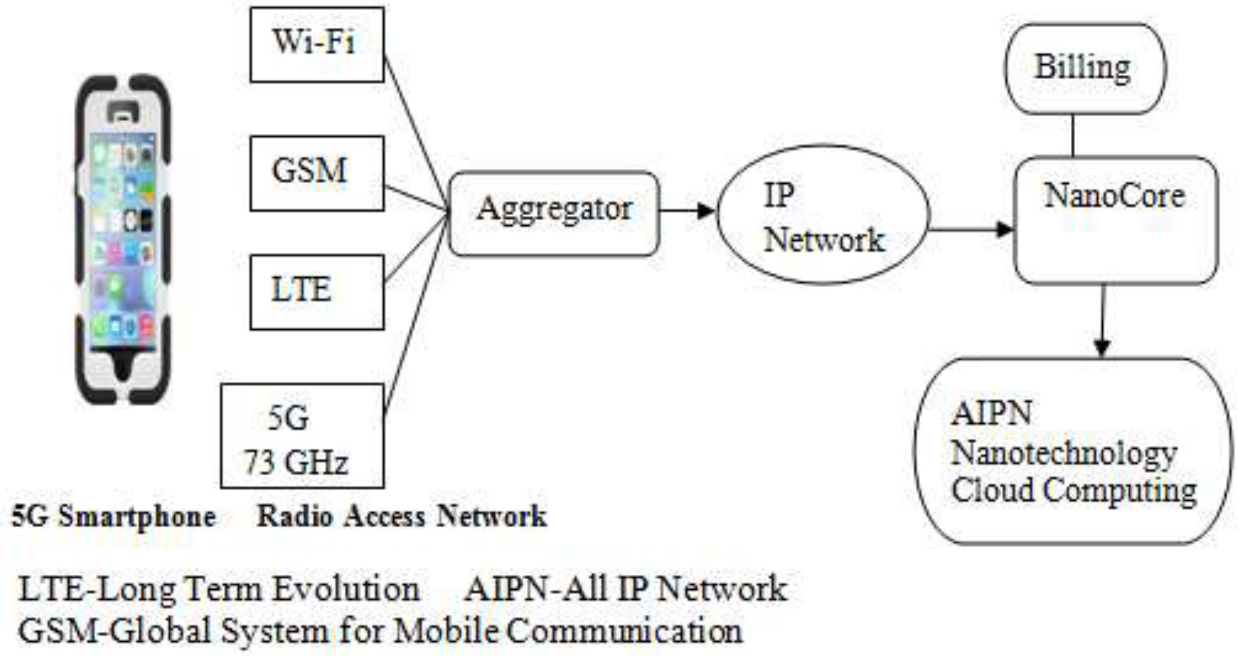


Figure.5 5G Architecture.

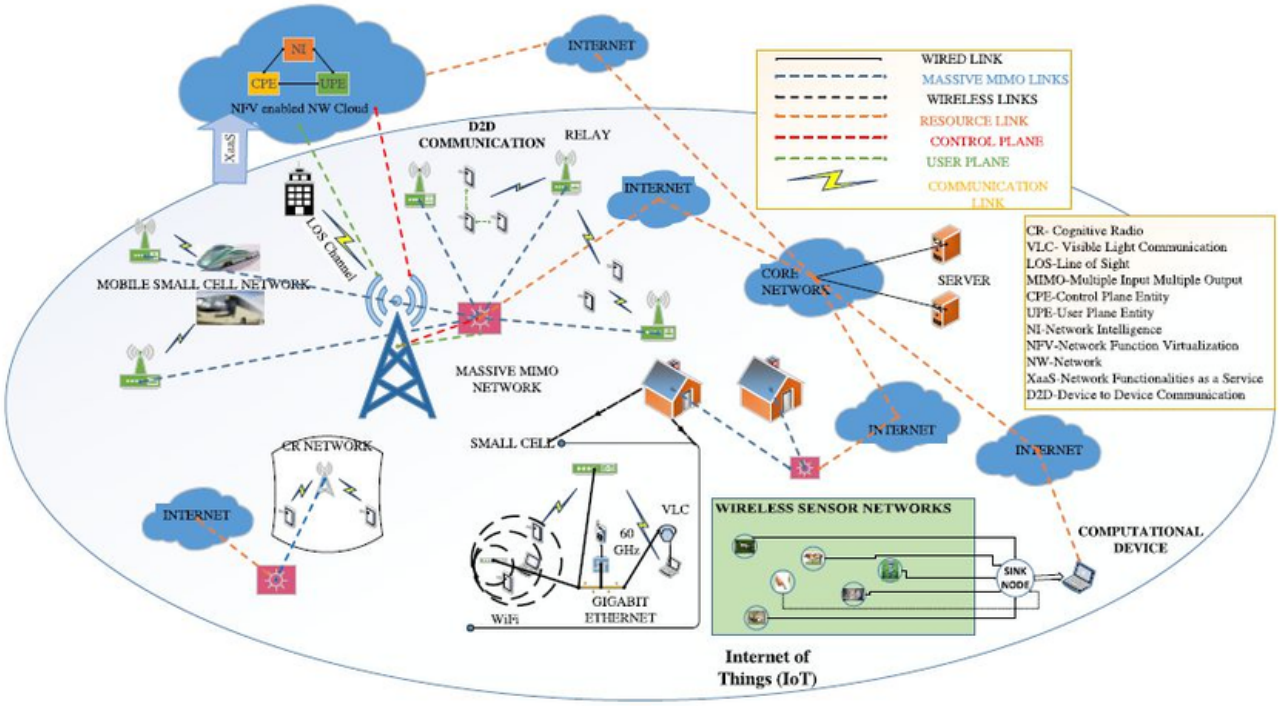


Figure.6 5G Cellular Network.

General Comparisons of 1G, 2G, 3G, 4G and 5G:

TECHNOLOGY	1G	2G/2.5G	3G	4G/4.5GLTE	5G
DEPLOYMENT	1970/1984	1980/1999	1990/2002	2000/2010	2014/2015
BANDWIDTH	2kpbs	14-64Kpbs	2mbps	200 Mbps	>1gbps
TECHNOLOGY	Analog Cellular	Digital cellular	Broadband width/ CDMA/ ip technology	Unified ip& seamless combo of LAN/WAN/WLAN/ PAN	4G+WWWW
SERVICE	Mobile telephony	Digital voice, Short Messaging, Data connectivity	Universal access to different mobile devices made possible along with multimedia & streaming service	High Definition Streaming supported. Probability increased further.	Dynamic information access variable devices with all capabilities
MULTIPLEXING	FDMA	TDMA/CDMA	CDMA	CDMA	CDMA
SWITCHING	Circuit	Circuit/Circuit for access networks & air interface	Packet except for air interface	All packet	All packet
CORE NETWORK	PSTN	PSTN	Packet network	Internet	Internet
HANDOFF	Horizontal	Horizontal	Horizontal	Horizontal & vertical	Horizontal & vertical
STANDARDS	AMPS,TACS, NMT	TDMA, CDMA, GSM, PDC	GPRS,EDGE,,1xRTT	WCDMA, CDMA2000	Single standard
WEB STANDARD	–	www	www(IPv4)	www(IPv4)	wwww(IPv6)
Advantage	Simpler network elements	Multimedia features (SMS, MMS). Internet access and SIM introduced	High security, International roaming	Speed, High speed handoffs, MIMO technology, Global mobility	Globally accessible, Dynamic information access
SHORTFALLS	Low capacity, unreliable handoff, Poor Voice links, Less secure	Digital signals were reliant on location & proximity, required strong digital signals to help mobile phones	Need to accommodate higher network capacity	Being Deployed	Developing infrastructure needs high cost. Security and privacy issue yet to be solved.

Figure.7 comparison of all mobile generations.