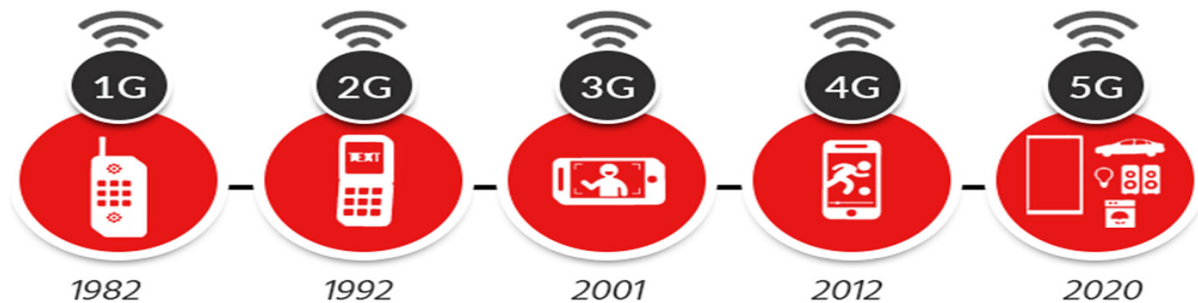


Comparison between wireless generations (1G, 2G, 3G, 4G, 5G) A survey.

Mobile communication system providing the way to which people communicate, sharing messages and data to each other. These facilities are provided to the user within a very short time period with the latest technologies.

The technologies of mobile communication is started from first generation (1G) and reached to the fifth generation (5G). First generation start from providing basic services mobile voice, second generation support mobile voice as well as low bit rate data services, 3G started high volume movement of data was possible which will further expanded to high speed technologies and high mobility and then 5G mobile communication system with high bandwidth with wide coverage area.

This survey provides a comparison overview of all mobile communication generation from 1G to 5G.



Comparison of mobile technologies

The comparison will include the following for each generation:

- Definition
- Setup requirements
- Bandwidth
- Data rate
- Service
- Standards
- Multiple access
- Freequency
- Properties

Technology	1G	2G	3G	4G	5G
Definition	The first generation mobile communication system was introduced in the beginning of 1980 and uses analog transmission for speech services.	The second generation is a successor of 1G due to the analog speech signals, low data rate and insufficient data communication, which provides high speed data communication	The third generation is originally designed for higher speed internet access and various types of web browsing applications. One of it services that it provides video conferencing	The fourth generation provides various features which are not involved in Third generation like Video conferencing, gaming services, IP telephony, high definition (HD) mobile TV	The fifth generation is meant to deliver higher multi-Gbps peak data speeds, ultra low latency, more reliability, massive network capacity, increased availability, and a more uniform user experience to more users. Higher performance and improved efficiency empower new user experiences and connects new industries

		as well as voice transmission			
Requirements	No official Requirements Analog technology	No official Requirement S Digital Technology	ITU's IMT- 2000 required 144 kbps mobile, 384 kbps pedestrian, 2 Mbps indoors	ITU's IMT Advanced requirements include ability to operate in up to 40 MHz radio channels and with very high spectral Efficiency.	at least 1 GB/s or more data rates to support ultra-high definition video and virtual reality. applications, 10 GB/s data rates to support mobile cloud service
Bandwidth	1.9 kbps	14 kbps to 384 kbps	2 Mbps	2 Mbps to 1 Gbps	1Gbps & Higher (as demand)
Data rate	>6.9 Kbps	>14.4 Kbps	>2 Mbps	>200 Mbps	>10 Gbps
Service	Analog voice	Digital voice Higher capacity. packetized data	Integrated high quality audio, video and data	Dynamic information access, wear-able devices, HD streaming. global roaming:	Dynamic information access, wear-able devices, HD streaming: any demand of users: upcoming all technologies: global roaming smoothly:
Standards	NMT. AMPS. Hicap, CDPD, TACS, ETACS	GSM.GPRS. EDGE ETC.	WCDMA. CDMA 2000.	All access convergence including: OFMDA,MC-CDMA Network-LMPS	CDMA & BDMA

Multiple access	FDMA	TDMA CDMA	CDMA	CDMA	CDMA & BDMA
Properties	<ul style="list-style-type: none"> - Used analog signals. - Used an FDD scheme and typically allocated bandwidth of 25 Mhz. - Coverage area was small. - No roaming support between various operators. Low sound quality. 	<ul style="list-style-type: none"> - Shifted from analog to digital. - Supported voice and SMS(multimedia message service) both. - Supported all 4 sectors of wireless industry namely Digital cellular, Mobile Data, PCS, WLAN, - Moderate mobile data service. - Provides high data rate & large area coverage. 	<ul style="list-style-type: none"> - The Internet system was improved. - Better system and capacity. - Offers high speed wireless internet. Connection used was UMTS and WCMA. 	<ul style="list-style-type: none"> - IP based protocols. - LTE (Long term evaluation) was mainly for the internet. - Vo-LTE (Voice over LTE) is for both voice and internet. - Freedom and flexibility to select any desired service with reasonable QOS. - High usability. - Supports multimedia service at low transmission cost. - HD quality Streaming. 	<ul style="list-style-type: none"> - Higher data rates. - Connectivity will be more fast and secure, - Data Latency will be reduced to a great level. - Massive network capacity. It is 30 times faster than 4G. - More flexibility in the network.

Bandwidth : is defined as the potential of the data that is to be transferred in a specific period of time. It is the data carrying capacity of the network or transmission medium.

It is generally measured in

- Bits per second(bps)
- Megabits per second(Mbps)
- Gigabits per second(Gbps)

For example, if bandwidth is 100 Mbps, it means maximum 100 Mb data can be transferred per second on that channel.

Data rate: is defined as *the amount of data transmitted during a specified time period over a network. It is the speed at which data is transferred from one device to another or between a peripheral device and the computer.* It is generally measured in Megabits per second(Mbps) or Megabytes per second(MBps).

For example, if bandwidth is 100 Mbps but data rate is 50 Mbps, it means maximum 100 Mb data can be transferred but the channel is transmitting only 50 Mb data per second.

Multiple access schemes are used to allow many mobile users to share simultaneously a finite amount of radio spectrum. In wireless communication systems, it is often desirable to allow the subscriber to send information simultaneously from the mobile station to the base station while receiving information from the base station to the mobile station.

A cellular system divides any given area into cells where a mobile unit in each cell communicates with a base station. The main aim in the cellular system design is to be able to **increase the capacity of the channel**, i.e., to handle as many calls as possible in a given bandwidth with a sufficient level of quality of service.

There are several different ways to allow access to the channel. These includes mainly the following :

- Frequency division multiple-access (FDMA)

- Time division multiple-access (TDMA)
- Code division multiple-access (CDMA)
- Space division multiple access (SDMA)

Depending on how the available bandwidth is allocated to the users, these techniques can be classified as narrowband and wideband systems.

Services means any service using licensed or unlicensed wireless spectrum, including the use of Wi-Fi, whether at a fixed location or by means of a mobile device, that is provided using wireless facilities.

Standards means all cellular communication technical specifications adopted as a standard by either a standards development organization (SDO) or a major operator of public subscription systems for in-country requirements.