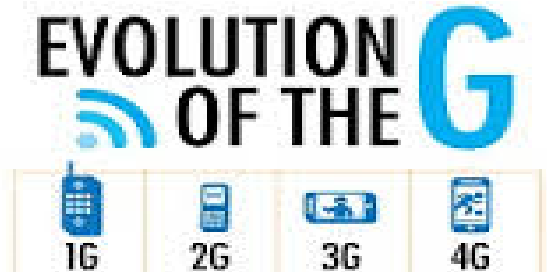


# A STUDY ON GENERATIONS OF MOBILE TECHNOLOGY AND THEIR COMPARISON

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**Abstract**— It is the need of hour to get ourselves acquainted with the communication technology, its tools and its trends. Mobile communication is an important technology in this regard and mobile phone has become the most common tool of communication over the recent years. As several innovative improvements regarding mobile communication technologies have been made by developing various multiple-access schemes used for wireless communication (such as TDMA, FDMA, CDMA, WCDMA, EDGE etc.) but a big challenge is to select the right technology for the applications and systematically identify the factors that influence the overall performance. In this paper, we review architecture and functionality of Third generation (3G) mobile technology and compare it with various existing generations of mobile wireless technology vis-à-vis in terms of their portals, performance, advantages and disadvantages. [1]



## I. INTRODUCTION

### FIRST GENERATION:

The first generation (1G) mobile communications technologies had limited capacity, serving only niche markets for the military, certain government agencies and users in special industries( e.g. loggers, construction foreman, realtors and celebrities)[2]

A set of wireless standards developed in the 1980's, 1G technology replaced 0G technology, which featured mobile radio telephones and such technologies as Mobile Telephone System (MTS), Advanced Mobile Telephone System (AMTS), Improved Mobile Telephone Service (IMTS), and Push to Talk (PTT). 1G wireless networks used analog radio signals. Through 1G, a voice call gets modulated to a higher frequency of about 150MHz and up as it is transmitted

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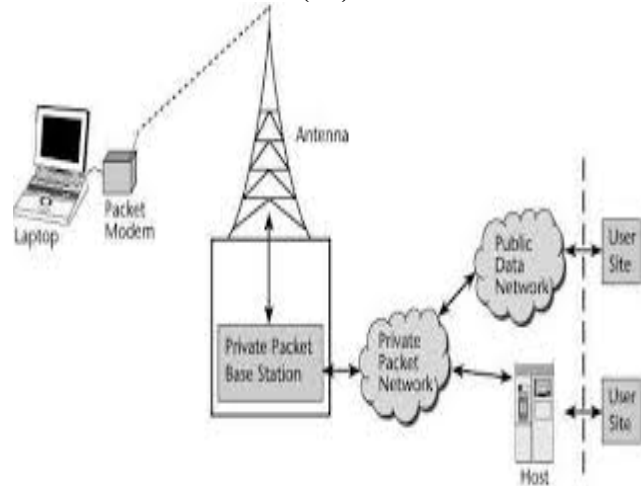
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between radio towers. This is done using a technique called Frequency-Division Multiple Access (FDMA).



### AMPS ARCHITECTURE (1G):



### Different 1G standard were used in various countries:

1. Advanced Mobile Phone System (AMPS) was a 1G standard used in the United States.
2. Nordic Mobile Telephone (NMT) was a 1G standard used in Nordic countries (Denmark, Finland, Iceland, Norway and Sweden), as well as in its neighboring countries Switzerland and Netherlands, Eastern Europe, and Russia.
3. Italy used a telecommunications system called RTMI.
4. In the United Kingdom, Total Access Communication System (TACS) was used.
5. France used Radiocom 2000.
6. In West Germany, Portugal, and South Africa, a telecommunications system known as C-450 was used.[3]

### ADVANTAGES:

#### ➤ Mobility:

Compared to earlier phones, which required wired connections to the telephone network, 1G phone gave users true mobility for the first time, allowing people to take phones outdoors and in cars. Though bulky by modern standards, most 1G mobile phones were comparable in size to a standard telephone handset.

#### ➤ Pricing Plans:

1G mobile phones were also among the first cell phones that service providers marketed directly to individual users. Because of their cost, the phones were aimed at high-end consumers such as executives and the very wealthy. However, even these customers required standardized monthly bills based on consistent service rates.

➤ **Cost:**

In the late-1980s, cell phone providers began to invest in the next-generation, 2G network. This was to be an all-digital network offering higher-quality calls, more bandwidth to accommodate more users and a greater coverage area. 2G cell phones began appearing in the early-1990s.

For a time, with new, high-tech 2G phones on the market, the price of 1G mobile phones fell as demand slacked off. This marked the beginning of mobile phones that were affordable to a large number of middle-class users

**DISADVANTAGES:**

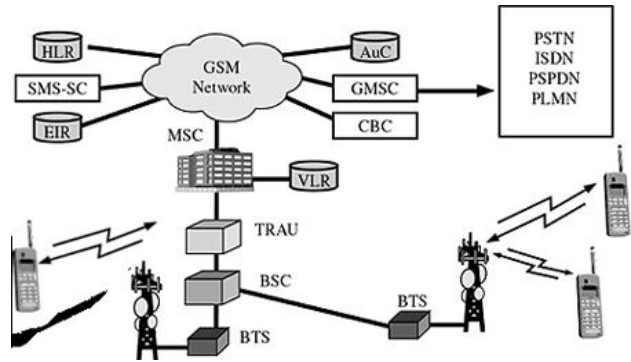
- The main disadvantage of 1g technology is that it makes use of analog rather than digital signals. This is a less effective means of transmitting information.
- It is significantly slower, and signals cannot reach as far in terms of secluded areas and such - 2g and 3g signal is far more widespread.
- In addition, analog signals are more likely to suffer interference problems. This can make using a mobile phone with analog signal more difficult. In all, the newer brands of 2g and 3g technology are more highly recommended.

**SECOND GENERATION:**



- Second generation (2g) telephone technology is based on GSM or in other words global system for mobile communication.
- Second generation was launched in Finland in the year 1991.
- 2G network allows for much greater penetration intensity. 2G technologies enabled the various mobile phone networks to provide the services such as text messages, picture messages and MMS (multimedia messages).
- 2G technology is more efficient.
- 2G technology holds sufficient security for both the sender and the receiver. All text messages are digitally encrypted. This digital encryption allows for the transfer of data in such a way that only the intended receiver can receive and read it.
- A benefit of 2G technology (Second Generation) is the voice clarity and reduces noise in the line. Digital signals are considered environment friendly.[4]

**GSM ARCHITECTURE (2G):**



**Capacity:**

Using digital signals between the handsets and the towers increases system capacity in two key ways:

1. Digital voice data can be compressed and multiplexed much more effectively than analog voice encodings through the use of various codecs, allowing more calls to be transmitted in same amount of radio bandwidth.
2. The digital systems were designed to emit less radio power from the handsets. This meant that cells had to be smaller, so more cells had to be placed in the same amount of space. This was possible because cell towers and related equipment had become less expensive.

**2G Data Transmission Capacity:**

1. With GPRS (General Packet Radio Service), you have a theoretical transfer speed of max. 50 kbit/s (40 kbit/s in practice).
2. With EDGE (Enhanced Data Rates for GSM Evolution), you have a theoretical transfer speed of max. 250 kbit/s (150 kbit/s in practice).

**Disadvantages:**

- In less populous areas, the weaker digital signal transmitted by a cellular phone may not be sufficient to reach a cell tower. This tends to be a particular problem on 2G systems deployed on higher frequencies, but is mostly not a problem on 2G systems deployed on lower frequencies. National regulations differ greatly among countries which dictate where 2G can be deployed.
- Analog has a smooth decay curve, but digital has a jagged stepy one. This can be both an advantage and a disadvantage. Under good conditions, digital will sound better. Under slightly worse conditions, analog will experience static, while digital has occasional dropouts. As conditions worsen, though, digital will start to completely fail, by dropping calls or being unintelligible, while analog slowly gets worse, generally holding a call longer and allowing at least some of the audio transmitted to be understood.

**Advantage:**

While digital calls tend to be free of static and background noise, the lossy compression they use reduces their quality, meaning that the range of sound that they convey is reduced.

Talking on a digital cell phone, a caller hears less of the tonality of someone's voice.[5]

**2.5G:**



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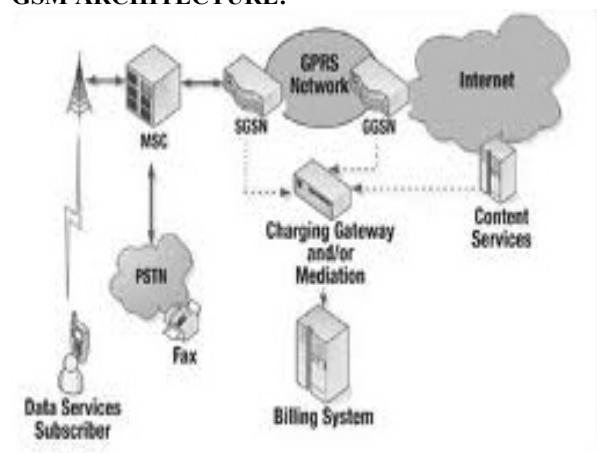
General Packet Radio Service (GPRS) is a mobile data service available to users of GSM mobile phones. It is often described as "2.5G", that is, a technology between the second (2G) and third (3G) generations of mobile telephony. It provides moderate speed data transfer, by using unused TDMA channels in the GSM network. Originally there was some thought to extend GPRS to cover other standards, but instead those networks are being converted to use the GSM standard, so that is the only kind of network where GPRS is in use. GPRS is integrated into GSM standards releases starting with Release 97 and onwards. First it was standardized by ETSI but now that effort has been handed onto the 3GPP. The GPRS core network allows 2G, 3G and WCDMA mobile networks to transmit IP packets to external networks such as the Internet. The GPRS system is an integrated part of the GSM network switching subsystem.

**SERVICES OFFERED:**

GPRS extends the GSM Packet circuit switched data capabilities and makes the following services possible:

- ✓ SMS messaging and broadcasting.
- ✓ "Always on" internet access.
- ✓ Multimedia messaging service (MMS).
- ✓ Push to talk over cellular (PoC).
- ✓ Instant messaging and presence—wireless village.
- ✓ Internet applications for smart devices through wireless application protocol (WAP).
- ✓ Point-to-point (P2P) service: inter-networking with the Internet (IP).
- ✓ Point-to-Multipoint (P2M) service.[6]

**GSM ARCHITECTURE:**



**2.75G– EDGE**

(Enhanced Data rates for GSM Evolution or Enhanced GPRS): It is a digital mobile phone technology which acts as a bolt-on enhancement to 2G and 2.5G General Packet Radio Service (GPRS) networks. EDGE technology was invented and introduced by Cingular, which is now known as AT& T. EDGE is radio technology and is a part of third generation technologies. EDGE technology is an extended version of GSM. It allows the clear and fast transmission of data and information. It is also termed as IMT-SC or single carrier. EDGE technology is preferred over GSM due to its flexibility to carry packet witch data and circuit switch data. The use of EDGE technology has augmented the use of black berry, N97 and N95 mobile phones. The biggest advantage of using EDGE technology is one does not need to install any additional hardware and software in order to make use of EDGE Technology. There are no additional charges for exploiting this technology. [7]



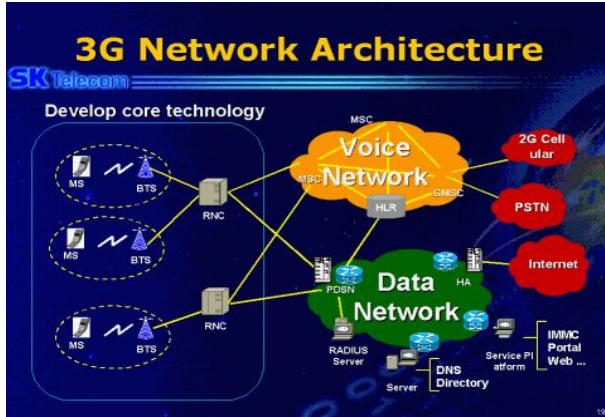
3G, short form of third Generation, is the third generation of mobile telecommunications technology. This is based on a set of standards used for mobile devices and mobile telecommunications use services and networks that comply with the International Mobile Telecommunications-2000 (IMT-2000) specifications by the International Telecommunication Union. 3G finds application in wireless voice telephony, mobile Internet access, fixed wireless Internet access, video calls and mobile TV. 3G TV technologies. A new generation of cellular standards has appeared approximately every tenth year since 1G systems were introduced in 1981/1982. Each generation is characterized by new frequency bands, higher data rates and non-backward-compatible transmission technology. The first 3G networks were introduced in 1998 and fourth generation "4G" networks in 2008. [8]

**A LOOK AT 3G SERVICES:**

In general terms, 3G services comprise of wide bandwidth services such as enhanced communication (e.g. messaging, e-mail, video), browsing the Web (Robins, 2003; Symbian Glossary, 2004), and location-specific information (Barnes, 2002) like informing users about the availability of stores, restaurants, gas stations, free parking lots and so on near them (Kanter, 2003). In addition, business users will have a direct access to company networks while traveling or working outside office. From marketing point of view, identifying and designing these services and setting an appropriate price is said to be the core marketing task related to 3G (Robins, 2003). Although it can be concluded that the most successful 3G services probably belong to one of these categories, it is

impossible to predict in detail exactly what is going to happen in the mobile marketplace. However, we will not experience a so-called radical innovation in the market; merely the evolution of existing mobile communications giving users faster transmission speeds which then might open up possibilities for new mobile data services also. Next, we will go through the most common mobile data services and ponder their ability to serve as the most successful 3G services.

**3G NETWORK ARCHITECTURE:**



**Advantages of 3G:**

- ✚ Overcrowding is relieved in existing systems with radio spectrum
- ✚ Bandwidth, security and reliability are more
- ✚ Provides interoperability among service providers
- ✚ Availability of fixed and variable rates
- ✚ Support to devices with backward compatibility with existing networks
- ✚ Always online devices – 3G uses IP connectivity which is packet based
- ✚ Rich multimedia services are available

**Disadvantages of 3G:**

- ✚ The cost of cellular infrastructure , upgrading base stations is very high
- ✚ Needs different handsets.
- ✚ Roaming and data/voice work together has not yet been implemented
- ✚ Power consumption is high
- ✚ Requires closer base stations and are expensive
- ✚ Spectrum-license costs, network deployment costs and handset subsidies subscribers are tremendous.



In a world of fast changing technology, there is a rising requirement for people to communicate and get connected with each other and have appropriate and timely access to information regardless of the location of the each individuals or the information. The increasing demands and requirements for wireless communication systems ubiquity have led to the need for a better understanding of fundamental issues in communication theory and electromagnetic and their implications for the design of highly-capable wireless systems. In continuous development of mobile environments, the major service providers in the wireless market kept on monitoring the growths of a Critical Review of Various Generations of Mobile Network Technologies.

2G and 3G are well-established as the mainstream mobile technology around the world. 3G is stumbling to obtain market share for a different reasons and 4G is achieving some confidence. The 4G technology includes the best features of 2G, 3G, Wi-Fi, Wi-PAN (Bluetooth), and WiMAX technologies with additive features. Packing so much intelligence in smaller and smaller physical space, esp. User Equipment (UE) 4G can be defined as:

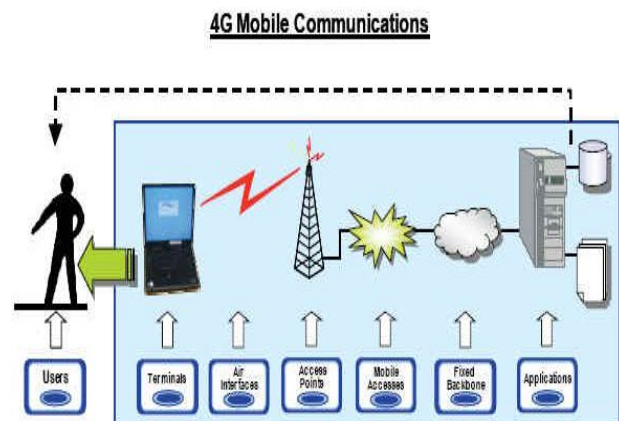
**“IP + WPAN + WLAN + WMAN + WWAN + any other stragglers = 4G”**

The entire network would be packet-switched (IP Based). All switches would be digital. Higher bandwidths of 100MHz, and data could be transferred at much higher rates the cost of data transfer would be comparatively very less and global mobility would be possible. The security features will be much better. The smart antennas will be used and improved access technologies like OFDM and MC-CDMA (Multi Carrier) will be used.

**4G CHARACTERISTICS:**

- ✚ Convergence services.
- ✚ Broadband services
- ✚ Interactive BCN (ALL-IP) with home networking,telemetric,sensor network
- ✚ Flexibility and personalized service.

**4G NETWORK ARCHITECTURE:**



**COMPARISON OF ALL GENERATIONS:**

<b>1G</b>	<b>4G</b>
<ol style="list-style-type: none"> <li>1. 1G is the first generation that existed in 1980s.</li> <li>2. It is based on analog signals.</li> <li>3. It supports data band width in kbps.</li> <li>4. Poor carrier aggregation.</li> <li>5. No MIMO technology.</li> <li>6. Very large cells may range from 2- 20 km.</li> <li>7. Peak speed up to 1.9 kbps.</li> <li>8. Poor or no security.</li> <li>9. Time consuming.</li> </ol>	<ol style="list-style-type: none"> <li>1. 4G is the fourth generation that evolved in late 1990 and early 00s.</li> <li>2. It is based on wireless communication which is IP based.</li> <li>3. It supports data band width in Mbps.</li> <li>4. Multiple carrier aggregation.</li> <li>5. Advanced MIMO technology.</li> <li>6. Extremely dense and small cells.</li> <li>7. Peak speed up to 150 Mbps.</li> <li>8. High security.</li> <li>9. Very fast in connecting</li> </ol>

<b>2G</b>	<b>4G</b>
<ol style="list-style-type: none"> <li>1. 2G was present in 1990.</li> <li>2. It is wireless telephone technology launched on GSM standards</li> <li>3. Based on digital voice.</li> <li>4. It is based on CODEC.</li> <li>5. It is mainly used for mobile communication.</li> <li>6. It has core network as PSTN.</li> <li>7. Peak speed may be up to 14.4 kbps.</li> <li>8. TDMA, CDMA technologies are part of 2G.</li> <li>9. Carrier bit rate is 270.8 kbps &amp; speech coding bit rate is 13kbps</li> <li>10. Channel Bandwidth 200 k Hz in GSM.</li> <li>11. Safe for consumers to use.</li> <li>12. Handsets are provided with text messaging.</li> <li>13. No QoS (quality of service).</li> <li>14. Cannot take multiple parties simultaneously.</li> </ol>	<ol style="list-style-type: none"> <li>1. 4G is present since 2000.</li> <li>2. 4G is the fourth generation of mobile phone Mobile communication technology standards.</li> <li>3. Based on Internet Protocol.</li> <li>4. It is based on MAGIC.</li> <li>5. It is for mobile communication as well as Wireless internet.</li> <li>6. It has core network as Internet.</li> <li>7. Peak speed may be up to 150 Mbps.</li> <li>8. WiMAX, Lte technologies are part of 4G.</li> <li>9. Bit rate between 20- 200 mbps.</li> <li>10. Flexible channel band width.</li> <li>11. Safer for user than 2G.</li> <li>12. Handsets are provided with Wi-Fi, Bluetooth,</li> </ol>

<p>Internet etc.</p> <ol style="list-style-type: none"> <li>13. High QoS (quality of service).</li> <li>14. Very much capable in taking multiple parties simultaneously.</li> </ol>
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<b>3G</b>	<b>4G</b>
<ol style="list-style-type: none"> <li>1. 3<sup>rd</sup> generation of mobile telecommunications technology also called Tri-Band 3G.</li> <li>2. It is the successor to 2G technology.</li> <li>3. It has various release versions like 3.5G, 3.75G.</li> <li>4. The technologies under it are CDMA 2000, UMTS, EDGE, 1XRTT, EVDO.</li> <li>5. It based on high capacity broadband data.</li> <li>6. It has data bandwidth of 2Mbps.</li> <li>7. It has bandwidth of 5-10 Mbps.</li> <li>8. The spectral efficiency ranges from 1-5 Mhz.</li> <li>9. Costly in implementation.</li> <li>10. The data throughput is up to 3.1Mbps.</li> <li>11. It has a peak upload rate of 5 Mbps.</li> <li>12. The peak download rate is 100 Mbps.</li> <li>13. It supports packet switching.</li> <li>14. Its network architecture is wide area cell based.</li> <li>15. It uses turbo codes for error correction.</li> <li>16. It has frequency band of 1.8-2.5 GHz.</li> <li>17. It provides video access to the user.</li> <li>18. No virtual presence.</li> <li>19. It provides digital navigation.</li> </ol>	<ol style="list-style-type: none"> <li>1. 4G is the fourth generation of mobile phone Mobile communication technology standards.</li> <li>2. It is the successor to 3G technology.</li> <li>3. It do not have its own release versions whereas it has release versions of technologies under it.</li> <li>4. The technologies under it are WiMAX, Lte.</li> <li>5. It is completely based on Internet Protocol.</li> <li>6. It has data bandwidth of 200Mbps.</li> <li>7. Flexible bandwidth.</li> <li>8. The spectral efficiency could be 20 Mhz.</li> <li>9. Low cost than 3G.</li> <li>10. The data throughput practically is 3-5Mbps and potentially it is 100-300 Mbps.</li> <li>11. It has a peak upload rate of 500 Mbps.</li> <li>12. The peak download rate is 1 Gbps.</li> <li>13. It supports packet as well as message switching.</li> <li>14. Its network architecture is integration of wireless LAN and wide area network.</li> <li>15. It uses concatenated codes for error correction.</li> </ol>

- 16. It has frequency band of 2-8 GHz.
  - 17. It provides HD video access to the users.
  - 18. Virtual presence is also possible.
  - 19. It provides virtual navigation
- 

### **CONCLUSION**

Mobile Network Technologies have integrated the world as a global family where distances are no longer any hindrance for communication. The demand for wireless communication systems has resulted in the evolution of newer generations of wireless network technologies. From 1G to 4G, all these technologies have eased the living and communication standards but have their own sets of problems. More research is needed to evolve better technologies for faster and safer communication.

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