5G TECHNOLOGY REVOLUTION

Charu Gupta

1ME-Digital Communication, Department of Electronics & Communication Engineering, MBM Engineering College, JNV University, Jodhpur-342011

Abstract- Technologies like 5G and upcoming future generations of connectivity, when deployed in the 2020s, will provide higher bandwidth and lower latency than current-generation of 4G technology. 5G and future generations will be able to enable bandwidth in excess of 100s of Megabits per second (Mb/s) with latency of less than 1 millisecond (ms), as well as provide connectivity to billions of devices. Most importantly, these technologies are expected to enable new applications that will transform the way humans live, work, and engage with their environment. This paper throws light on all preceding generations of mobile communication along with fifth generation technology. Fifth generation network will be able to provide affordable broadband wireless connectivity (very high speed). This paper also throws light on network architecture of fifth generation technology. for implementing fifth generation technology various researches are being made on development of World Wide Wireless Web (WWWW), Dynamic Adhoc Wireless Networks (DAWN) and Real Wireless World. Fifth generation will mainly focus on (Voice Over IP) VOIP-enabled devices through which user will experience a high level of call volume and data transmission. The main feature of 5G mobile network is that user can simultaneously connect to the multiple wireless technologies and can switch between them.

Keywords- 5G, 5G Architecture, Evolution from 1G to 5G, Comparison of all Generations

I. BACKGROUND AND MOTIVATION

In the last 20 years of the previous century, mobile phones became pervasive among consumers. A new mobile generation has appeared approximately every 10 years since the first 1G systems were introduced in 1982. Mobile phones were originally perceived to be limited to voice communications. The first 2G systems were commercially deployed in 1992, and the 3G systems appeared in 2001. 4G systems were first standardized in 2012. The development of the 2G Groupe Speciale Mobile (GSM) and 3G standards took about 10 years from the official start of the research and development (R&D) projects, and development of 4G systems began in 2001-2002.

In a similar time period, the internet became accessible to the consumer community, as well. Initially, the communication capability of the internet was aimed at text messages; shortly after, access to multiple sites on the web also became available via the internet. The introduction of smart phones and tablets in 2007 and 2010, respectively, transformed the combination of these mobile appliances into instruments that, in addition to enabling voice calls, could navigate the internet and handle photos and video, download, and stream movies, among many other applications.

Some drastic upgrade/conversion of the whole communication infrastructure needs to happen by the year 2020 to support the forecasted growth in the flow of information. It is well known that the ability of a communication channel to carry high-quality audio or video information is directly proportional to the usable frequency bandwidth. This demand for broader channel bandwidth associated with the forecasted growth in the number of communication channel requires the use of higher frequencies above 3GHz where contiguous spectrum can be found to support wider communication channels.
New mobile generations are typically assigned new frequency bands and wider spectral bandwidth per frequency channel (1G up to 30 KHz, 2G up to 200 kHz, 3G up to 5 MHz, and 4G up to 20 MHz). But there is little room for larger channel bandwidths, and new frequency bands suitable for land-mobile radio would overlap with K-band (18 to 27GHz) transmissions of communication satellites. In addition, the path loss between transmitting and receiving antennas is proportional to the square of the frequency in accordance with Friis equation (Power received is proportional to Power transmitted/f^2). Furthermore, penetration loss, diffraction loss, etc., also increase with increasing frequency. The bands between 6 GHz and 30 GHz are important to consider for increased communication capacity, but, as the operational frequency is increased, the antenna gain at the transmitter and receiver must compensate these losses. All of the issues related to higher operational frequencies need to be well understood and resolved since the whole system design completely depends on this.

Fifth-generation mobile networks or fifth-generation wireless systems, abbreviated “5G,” are the proposed next telecommunications standards beyond the current 4G standards. 5G planning aims at higher capacity than current 4G, allowing a higher density of mobile broadband users and supporting device-to-device, ultra-reliable, and massive machine communications. 5G R&D also aims at lower latency than 4G equipment and lower battery consumption, for better implementation of the internet of things (IoT).

II. EVOLUTION OF WIRELESS TECHNOLOGIES

Mobile+ communication has become more popular in last few years due to fast revolution in mobile technology. This revolution is due to very high increase in telecoms customers. This revolution is from 1G- the first generation, 2G- the second generation, 3G- the third generation, and then the 4G- the forth generation, 5G- the fifth second generation.

A. First Generation(1G) 1G emerged in 1980s. It contains Analog System and popularly known as cell phones. It introduces mobile technologies such as Mobile Telephone System (MTS), Advanced Mobile Telephone System (AMTS), Improved Mobile Telephone Service (IMTS), and Push to Talk (PTT). It uses analog radio signal which have frequency 150 MHz, voice call modulation is done using a technique called Frequency-Division Multiple Access (FDMA). It has low capacity, unreliable handoff, poor voice links, and no security at all since voice calls were played back in radio towers, making these calls susceptible to unwanted eavesdropping by third parties.

B. Second Generation(2G) 2G emerged in late 1980s. It uses digital signals for voice transmission and has speed of 64 kbps. It provides facility of SMS(Short Message Service) and use the bandwidth of 30 to 200 KHz. Next to 2G, 2.5G system uses packet switched and circuit switched domain and provide data rate up to 144 kbps. E.g. GPRS, CDMA and EDGE

C. Third Generation(3G) It uses Wide Brand Wireless Network with which clarity is increased. The data are sent through the technology called Packet Switching. Voice calls are interpreted through Circuit Switching. Along with verbal communication it includes data services, access to television/video, new services like Global Roaming. It operates at a range of 2100MHz and has a bandwidth of 15-20MHz used for High-speed internet service, video chatting. 3G uses Wide Band Voice Channel that is by this the world has been contracted to a little village because a person can contact with other person located in any part of the world and can even send messages too.

D. Fourth Generation(4G) 4G offers a downloading speed of 100Mbps. 4G provides same feature as 3G and additional services like Multi-Media Newspapers, to watch T.V programs with more clarity and send Data much faster than previous generations. LTE (Long Term Evolution) is considered as 4G technology. 4G is being developed to accommodate the QoS and rate requirements set by forthcoming applications like wireless broadband access, Multimedia Messaging Service (MMS), video chat, mobile
TV, HDTV content, Digital Video Broadcasting (DVB), minimal services like voice and data, and other services that utilize bandwidth.

E. Fifth Generation (5G) As a result of blending of requirements, many of the industry initiatives that have progressed with work on 5G and have identified set of eight requirements for 5G:

- 1-10Gbps connections to end points in the field (i.e. not theoretical maximum)
- 1 millisecond end-to-end round trip delay (latency)
- 1000x bandwidth per unit area
- 10-100x number of connected devices
- (Perception of) 99.999% availability
- (Perception of) 100% coverage
- 90% reduction in network energy usage
- Up to ten year battery life for low power, machine-type devices.

| CONTENT         | 1G  | 2G  | 3G  | 4G  | 5G          |
|-----------------|-----|-----|-----|-----|-------------|
| START           | 1970| 1990| 2004| NOW | SOON (2020) |
| DATA BW         | 2kbps | 64kbps | 2Mbps | 1Gbps | >1Gbps      |
| MULTIPLEX       | FDMA | TDMA | CDMA | CDMA | CDMA        |
| SWITCHING       | CIRCUIT | CIRCUIT | PACKET | ALL PACKET | ALL PACKET |
| CORE NETWORK    | PSTN | PSTN | PACKET | INTERNET | INTERNET    |

Figure 1: Evolution of wireless technologies

III. 5G ARCHITECTURE

Fifth generation mobile systems model is all-IP based model for wireless and mobile networks interoperability. The All-IP Network (AIPN) is capable to fulfill increasing demands of the cellular communications market. It is a common platform for all radio access technologies. The AIPN uses packet switching and its continuous evolution provides optimized performance and cost. In fifth generation Network Architecture consist of a user terminal (which has a crucial role in the new architecture) and a number of independent, autonomous radio access technologies (RAT). In 5G Network Architecture all IP based mobile applications and services such as Mobile portals, Mobile commerce, Mobile health care, Mobile government, Mobile banking and others, are offered via Cloud Computing Resources (CCR). Cloud computing is a model for convenient on-demand network access to configurable computing resources (e.g., networks, servers, storage, applications, and services). Cloud computing allows consumers to use applications without installation and access their personal data at any computer with internet access. CCR links the Reconfigurable, Multi Technology Core (RMTC) with...
remote reconfiguration data from RRD attached to Reconfiguration Data models (RDM). The main challenge for a RMTC is to deal with increasing different radio access technologies. The core is a convergence of the nanotechnology, cloud computing and radio, and based on All IP Platform. Core changes its communication functions depending on status of the network and/or user demands. RMTC is connected to different radio access technologies ranging from 2G/GERAN to 3G/UTRAN and 4G/EUTRAN in addition to 802.11x WLAN and 802.16x WMAN. Other standards are also enabled such as IS/95, EV-DO, CDMA2000...etc. Interoperability process-criteria and mechanisms enable both terminal and RMTC to select from heterogeneous access systems.

![5G Network Architecture](image)

**Figure 2: 5G Network Architecture**

**IV. APPLICATIONS OF 5G**

It is interesting to note that most of the needs of the applications can be served with the current networks; however, the element of human interaction (or lack of it) demands guaranteed latency and makes most of the 5G requirements critical. The following table presents some emerging applications and services for which 5G will be a pivotal enabler.
### Table 1: Emerging Applications and Services enabled by 5G

| Verticals          | Drivers                                      | Enablers                                    | 5G requirement                           |
|--------------------|----------------------------------------------|---------------------------------------------|------------------------------------------|
| Education          | • Remote delivery                            | • Video streaming                           | • Large bandwidth                        |
|                    | • Immersive experiences                      | • Augmented reality/Virtual reality         | • Low latency                            |
| Manufacturing      | • Industrial automation                      | • Massive IoT networks                      | • High connection density                 |
|                    |                                              |                                              | • Ultra reliability                      |
|                    |                                              |                                              | • Low power                              |
| Healthcare         | • Remote diagnosis and intervention          | • Video streaming                           | • Low power                              |
|                    | • Long term monitoring                       | • Augmented reality/Virtual reality         | • High throughput                        |
|                    |                                              | • Embedded devices, advanced robotics       | • Low latency                            |
| Smart Grid         | • Intelligent demand/supply control          | • IoT sensors and networks                  | • High reliability                       |
|                    | • Powerline communication                    |                                              | • Broad coverage of network              |
| Entertainment      | • Immersive gaming and media industry        | • Video streaming                           | • Low latency                            |
|                    | • Multimedia experience at 4k                | • Augmented reality/Virtual reality         |                                          |
| Automotive/Autonomous Cars | • Collision avoidance                  | • Vehicle-to-vehicle (V2V), Vehicle-to-infrastructure (V2I) and other intelligent transport systems (ITS) | • Large bandwidth and low latencies (< 5 ms) and high connection reliability (99.999%) |
| Smart Cities       | • Connected utilities, Transportation, Healthcare, Education and all amenities | • Massive IoT networks, Automation, Cloud infrastructure, Artificial intelligence | • Large bandwidth                        |
|                    |                                              |                                              | • High throughput                        |
|                    |                                              |                                              | • High connection density                |
|                    |                                              |                                              | • Low latencies                          |

### V. WHY 5G

- Very High speed, high capacity, and low cost per bit.
- It supports interactive multimedia, voice, video, Internet, and other broadband services, more effective and more attractive, and have Bi-directional, accurate traffic statistics.
- 5G technology offers Global access and service portability.
- It offers the high quality services due to high error tolerance.
- It is providing large broadcasting capacity up to Gigabit which supporting almost 65,000 connections at a time. More applications combined with artificial intelligent (AI) as human life will be surrounded by artificial sensors which could be communicating with mobile phones.
- 5G technology use remote management that user can get better and fast solution.
- The uploading and downloading speed of 5Gtechnology is very high.
- 5G technology offer high resolution for crazy cell phone user and bi-directional large bandwidth shaping.
- 5G technology offer transporter class gateway with unparalleled consistency.
VI. CONCLUSIONS

Migration from 1G to 4G has been facilitated by the availability of readily usable or at least known technologies that required a limited amount of development. The migration from the operating frequency of 800MHz of 1G to the 1800MHz range of 4G did not have a major influence on signal propagation properties in air. The migration to digital technologies, introduction of new, more efficient protocols, and the extensive coverage provided by deployment of repeaters were the main contributors to enhanced performance. However, the use of frequencies beyond 6GHz will impose drastic restrictions on signal propagation distance. Furthermore, the inability of signals to circumvent obstacles will progressively become an even greater problem as higher frequencies are under consideration for future generations. 5G is not just an evolutionary upgrade of the previous generation of cellular, but it is a revolutionary technology envisioned that will eliminate the bounds of access, bandwidth, performance, and latency limitations on connectivity worldwide. 5G has the potential to enable fundamentally new applications, industries, and business models and dramatically improve quality of life around the world via unprecedented use cases that require high data-rate instantaneous communications, low latency, and massive connectivity for new applications for mobile, eHealth, autonomous vehicles, smart cities, smart homes, and the IoT.

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