

Analyzing 5G: Prospects of Future Technological Advancements in Mobile

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Abstract: A new mobile network generation usually refers to a completely new architecture from Analog (1G) to GSM (2G) to CDMA (3G) and finally to LTE (4G). So, the next fundamental step beyond fourth-generation LTE networks is being referred to as "5G" by the industry. The term 5G is also known as World Wide Wireless Web (WWWW). The main purpose of the 5G is to design the best wireless world that is free from limitations and hindrance of the previous generations because wireless system designers have been facing the continuously increasing demand for high data rates. This paper throws light on the development of 5G technologies as a cornerstone for realizing breakthroughs in the transformation of mobile networking. This paper represents the introduction of 5G technology, evolution, need, hardware and software requirements, specifications, network architecture of 5G wireless technologies and its future scope.

Keywords - 5G, MIMO, WWW, LTE, IoT, latency

I. Introduction

5G offers enormous potential for consumers and industry as well as the prospect of being considerably faster than existing technologies. 5G holds the promise of applications with high social and economic value in which mobile will play an ever more important role in people's lives leading to a 'hyper-connected society'. A significant role will be played by the Global System Mobile Association (GSMA) in shaping the strategic, commercial and regulatory development of the 5G ecosystem. Areas that will be included are the definition of roaming and interconnect in 5G, the identification and alignment of suitable spectrum bands. The technical requirements that necessitate a true generational shift for 5G are sub-1ms latency and >1 Gbps downlink speed. The 5G network is efficient and appealing as the billing interface is highly advanced. It offers huge quantity of broadcasting data in GB which can sustain more than 60,000 connections. It also offers huge bi-directional bandwidth [1].

Massive MIMO is a pre-5G technology that will make the network future ready for meeting the data demand coming from digital revolution. It provides faster data speeds on existing 4G mobile devices without any upgrades or plan change. Massive MIMO deployment uses green technology thereby reducing carbon footprint. It also creates 3D beams both on vertical and horizontal towards users that are located within its coverage footprint. The signal quality (SINR) is improved by 2-3dB due to the coverage and reducing interference across users in different beams. 5G uses data rate of 20 mbps and frequency band of 2-8 GHz which is enabled by OFDM and millimeter wireless. Recent technology constituents like high-speed packet access (HSPA) and long-term evolution (LTE) will be launched as a segment of the advancement of current wireless-based technologies. Overall, 5G will be aiming to reduce up to 90% of the power consumption in devices and network centers and strongly highlight itself as a greener technology[2].

II. 5G OFFICIAL LOGO



Fig. 1. 5G logo

III. EVOLUTION OF CELLULAR GENERATIONS

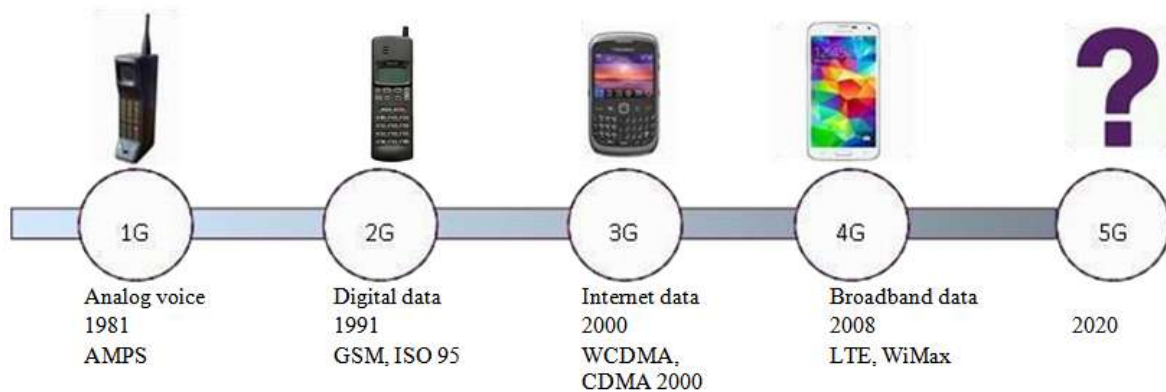


Fig. 2. Cellular Generations [2]

IV. COMPARISON OF ALL GENERATIONS OF MOBILE TECHNOLOGIES

TABLE 1. COMPARISON OF ALL THE GENERATIONS [3][4]

Technology Features	1G	2G	3G	4G	5G
Start/ Deployment	1970 – 1980	1990 - 2004	2004-2010	Now	probably 2020
Data Bandwidth	2kbps	64kbps	2Mbps	1 Gbps	Higher than 1Gbps
Technology	Analog Cellular Technology	Digital Cellular Technology	CDMA 2000, UMTS, EDGE	WiMax, LTE, Wi-Fi	WWW
Service	Mobile Telephony (Voice)	Digital voice, SMS, Higher capacity packetized data	Integrated high-quality audio, video and data	Dynamic Information access, Wearable devices	Dynamic Information access, Wearable devices with AI Capabilities
Multiplexing	FDMA	TDMA, CDMA	CDMA	CDMA	CDMA
Switching	Circuit	Circuit, Packet	Packet	All Packet	All Packet
Core Network	PSTN	PSTN	Packet N/W	Internet	Internet
Key differentiator	Mobility	Secure, mass adoption	Better internet experience	Faster broadband internet, lower latency	Lower battery consumption
Drawbacks	Low capacity, unreliable handoff, Poor voice links, less secure	Digital signals are reliant on location and proximity, Requires strong digital signals,	Accommodates lower network capacity	Being deployed	Yet to be implemented

V. FEATURES OF 5G:

- It has Ultra low latency which ranges between 1ms and 10ms.
- It gives enough capacity for unlimited data transfer.
- The 5G technology presents the high resolution and fast Internet access.
- It provides billing limits in advance which makes it more attractive and efficiency
- The information from the data transfer in 5G technology organizes a more accurate and reliable results.
- It also supports virtual private network.
- It has high peak bitrate
- Better connectivity irrespective of geographic region
- Supports large number of devices
- High capacity to allow more connectivity of devices concurrently and instantaneously [5].

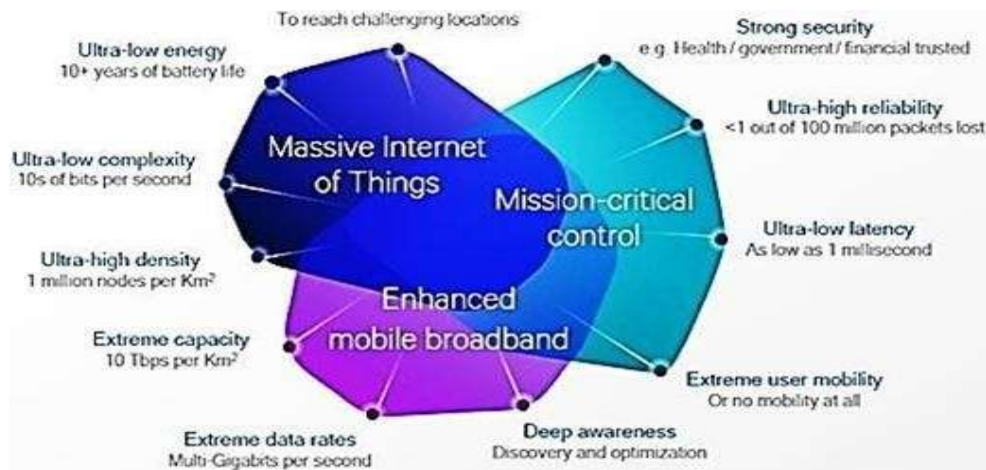


Fig. 3. Features of 5G

VI. REQUIREMENTS OF 5G:

Many of the industry initiatives that have progressed with works on 5G identify a set of eight requirements:

- 1-10Gbps connections to end points in the field
- 1 millisecond end-to-end round-trip delay (latency)
- 1000x bandwidth per unit area
- 10-100x number of connected devices
- (Estimation of) 100% coverage
- (Estimation of) 99.999% availability
- 90% reduction in network energy usage
- Up to ten years battery life for low power, machine-type devices [6].

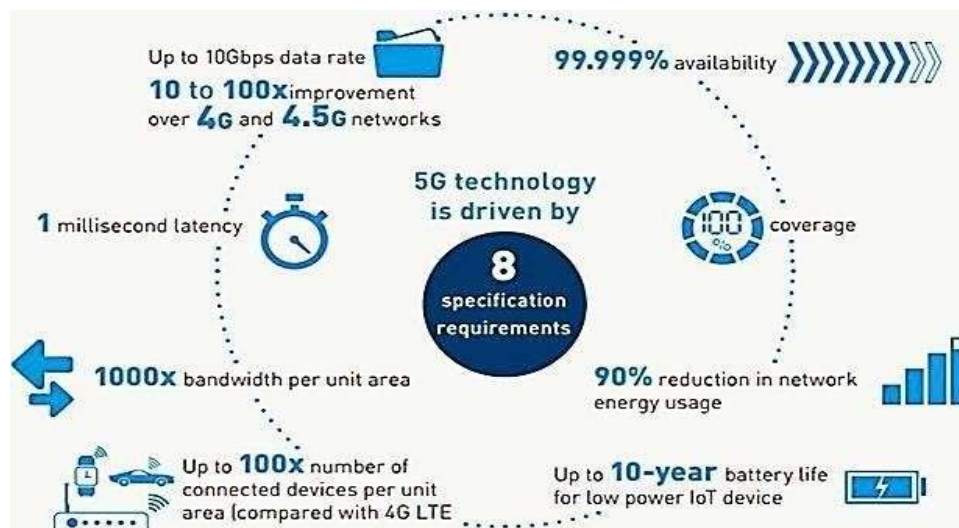


Fig. 4. Requirements of 5G [7]

VII. WHY DO WE NEED 5G?

- 5G will deliver superior user experience and better network energy efficiency, as well as increased operational performance
- Mostly due to video streaming, mobile data traffic is rising rapidly.
- Each user has a growing number of connections with multiple devices.
- The emergence of the IoT (Internet of Things) means networks must handle billions of more devices.
- Network operators are under pressure to reduce operational expenditure.
- Operators also need new applications for mobile technology which opens up new revenue streams [8].

VIII. 5G SPECIFICATIONS

Table 2. 5G SPECIFICATION TABLE [6]

PARAMETER	PERFORMANCE
Network capacity	10000 times the capacity of the current network
Peak data rate	20Gbps downlink and 10Gbps uplink
Cell edge data rate	100 Mbps
Latency	< 1 ms
Bandwidth	Possibly 1-2 GHZ
Connection density	1 million connected devices per square km (0.38 sq. miles)
5G mobility	500km/h high speed
Spectral efficiency	30bits/Hz downlink and 15 bits/Hz uplink

IX. HARDWARE REQUIREMENTS OF 5G TECHNOLOGY

9.1 UWB Networks

5G network technology has higher bandwidth at low energy levels. In addition, UWB provides the needed cost-effective, power-efficient, high bandwidth solution for relaying data from host devices to devices in the immediate area

9.2 Bandwidth

5G has 4000 megabits per second, which is 400 times faster than today's wireless networks.

9.3 Smart antennas

Switched Beam Antennas support radio positioning via Angle of Arrival (AOA) information collected from nearby devices.

Adaptive Array Antennas: It provides improved capacity and safety for wireless systems. This kind of arrays can be used for interference rejection through spatial altering, position location through direction ending measurements, and developing improved channel models through angle of arrival channel sounding measurements.

9.4 Multiplexing

CDMA (Code Division Multiple Access) employs analog- to-digital conversion in combination with spread spectrum technology. Audio input is first digitized into binary elements. The frequency of the transmitted signal is then made to vary according to a particular pattern, so that it can be intercepted only by a receiver whose frequency response is programmed with the same code, so it follows exactly along with the transmitter frequency [1].

X. SOFTWARE REQUIREMENTS OF 5G TECHNOLOGY

5G network will be the single unified standard of different wireless networks, including wireless technologies (e.g. IEEE 802.11), LAN/WAN and WWW, unified IP and combination of the broadband [9].

Other requirements are Software Defined Radio, Packet layer, implementation of packets, encryption, flexibility etc. [1].

XI. NETWORK ARCHITECTURE

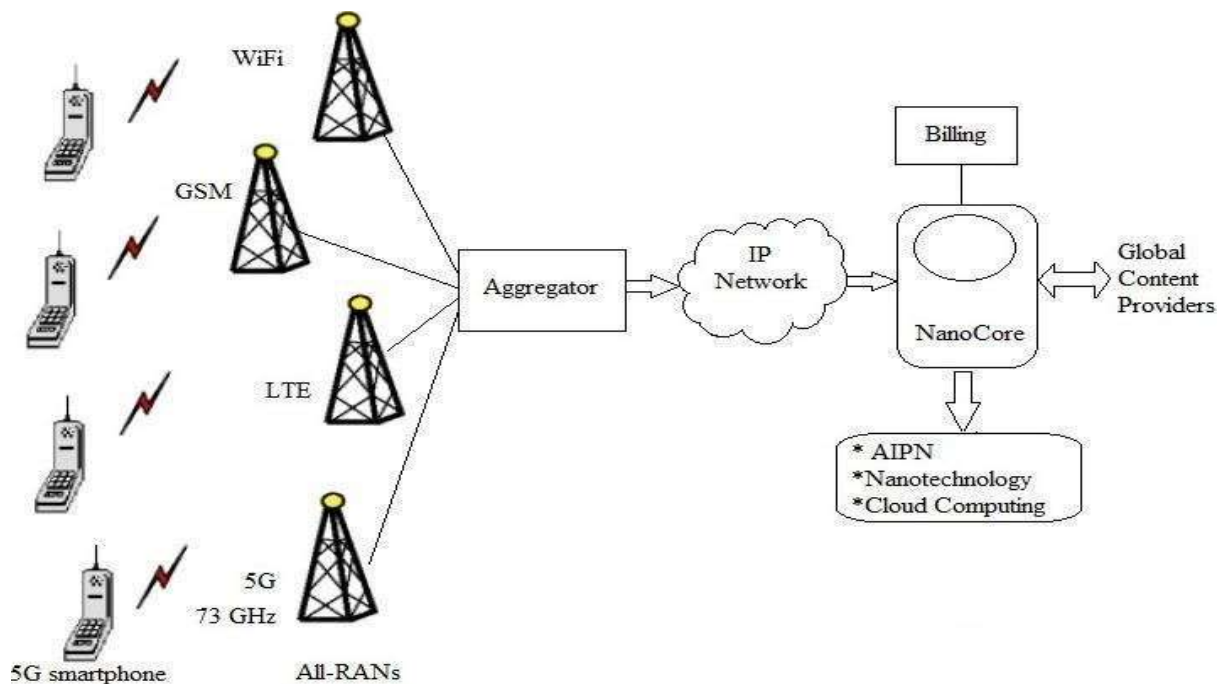


Fig. 5. Network Architecture for 5G [10]

Fig. 5 shows 5G network architecture for mobile systems. It uses flat IP concept, so that different RANs (Radio Access Networks) can use the same single Nanocore for communication. RANs which are supported by 5G architecture are WiFi, WiFiMAX, GSM, LTE etc.

11.1 Aggregator

5G aggregator which is located at BSC/RNC place aggregates all the RAN traffics and routes it to gateway

11.2 IPnetwork

It reduces number of network elements in data path and hence reduces the cost.

11.3 5Gnanocore

It comprises of All IP network (AIPN), nanotechnology, cloud computing [11].

11.4 AIPN

Flat IP architecture is an important part of 5G network. The All-IP Network (AIPN) is an evolution of the 3GPP system to meet the increasing demands of the mobile communications market. AIPN provides a competitive edge in terms of both performance and cost.

11.5 Nanotechnology

It is the application of nanoscience to control process on nanometer scale between 0.1 and 100 nm. Core features like self-cleaning, self-powered, sensible to the environment with which it is been interacting, flexible and transparent will be loaded with the nano equipment in the 5G nanocore [12].

11.6 CloudComputing:

A Technology that uses the central remote server and internet for maintaining data and applications is called Cloud Computing.

The Cloud computing has three segments as follows:

11.6.1 Applications: It is based on software services ondemand.

11.6.2 Platform: The products which are used to deploy internet is referred as the platform.

11.6.3 Infrastructure: The infrastructure is the backbone of the entire concept. Its vendors allow users to build applications in this platform [7][13].

XII. TECHNOLOGICAL CHALLENGES

12.1 Inter-cell Interference

It is caused due to variations in size of traditional macro cells and concurrent small cells.

12.2 Efficient Medium Access Control

The user throughput will be low, latency will be high, and hotspots will not be competent to cellular technology to provide high throughput where dense deployment of user terminals are required.

12.3 Traffic Management

Compared to traditional human to human traffic in cellular networks, overload and congestion can be caused due system challenges i.e. RAN challenges when the number of Machine to Machine (M2M) devices in a cell increases [14].

XIII. FUTURE SCOPE

5G technologies have revealed a new era in mobile communication technology. 5G technologies are likely to appear in the market by 2020. It is expected to significantly improve the Quality of Service in the context of increasing growth of data volume in mobile networks and wireless devices. The main aim of 5G is to design a Multi-Bandwidth data path by integrating the current and future networks for a new architecture of the 5G real wireless world. The user can simultaneously be connected with several wireless access technology and multiple data transfer path are possible. 5G technology offers high resolution for crazy cell phone users. TV channels can be watched at HD clarity on our mobile phones without any interruption. In 5G the network operators will be connected with one single core and have one single infrastructure which will be promoted by the concept of super-core.

XIV. CONCLUSION

In this paper, we have surveyed 5G technology for mobile communication. It is going to be a new revolution in wireless system market. The mobile network performance and capability requirements will be pushed to their extremes which will be given by the foundation of 5G. It is presenting many new challenges as well as opportunities for the test and monitoring industry 5G. Tremendous data capabilities, unrestricted call volumes and infinite data broadcast within the latest mobile operating system are offered by Fifth generation technologies. It should make an important difference and add more services and benefits to the world over 4G.

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