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EVOLUTION OF 5TH GENERATION (5G) TECHNOLOGY

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Abstract

The 5th Generation (5G) network technology is being implemented in many countries. The official name of 5G network technology is IMT 2020 standard. In India, also the large telecom operators like Vodafone-Idea, Bharti-Airtel, Reliance Jio are in the process to deploy the 5G networks. 5G is the successor technology of 1G/2G/3G/4G mobile network technologies. It is a new global network standard that has high bandwidth (10 Gbits/s), high connection density (106 devices/sq.km.), low delay (<1ms), and low consumption. In this paper, we have outlined the research challenges in the design and implementation of 5G network technology in India with their proposed solutions.

1. Introduction

The industry association which standardizes the 5G technology is the 3rd Generation Partnership Project (3GPP). The 3 GPP industry organization defines the specifications of 3G UMTS [1]. The following are the advantages of 5G over 4G wireless networks:

- High Speed
- More Capacity
- Low Latency (<1ms)
- More capable than 4G
- Better Spectrum Utilization

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2. Basic Block Diagram/Architecture of 5G Technology:

Figure 1 shows a basic block diagram of a 5G wireless network. It consists of user equipment (UE), Base Stations (BS), Radio Access Networks (RAN), Mobile Core, Cellular networks, and Internet cloud [2].

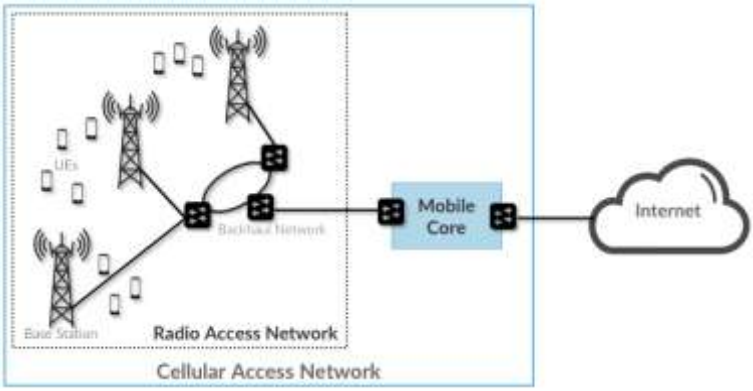

Figure 1. Cellular networks consist of a Radio Access Network (RAN) and a Mobile Core.

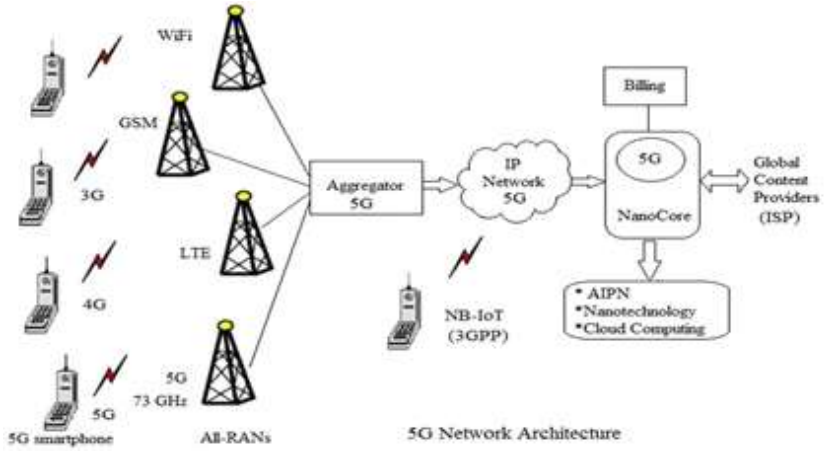

Figure 2. Architecture of 5G network system.

Figure 2 shows the architecture of the 5G network system. Here, all the networks i.e., Global system for mobile (GSM), Wireless Fidelity (Wi-Fi), Long Term Evolution (LTE) are connected to the IP network visa a 5G aggregator [3]. There is a 5G NanoCore layer that performs the functions of cloud

computing, user database management, national and international roaming of the user [4]. The User Equipment (UE) may be a smartphone, tablet, car, drone, industrial machine, home appliances, medical devices [5]. The block diagram consists of two main systems, i.e.

- Radio Access Network (RAN)
- Mobile Core

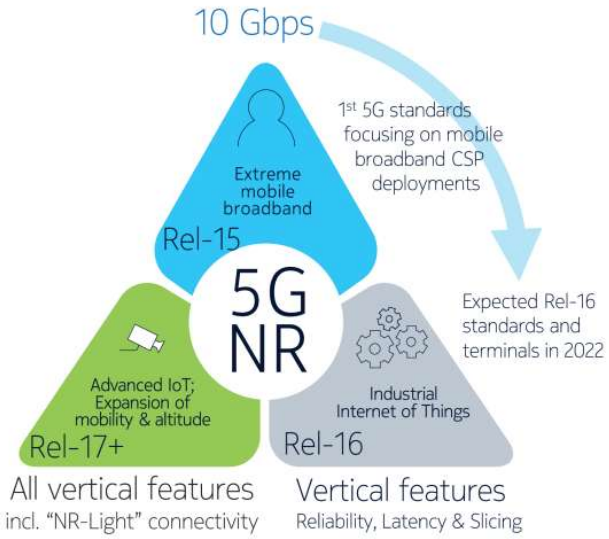

Figure 3. 5G New Radio (NR) eMBB, IIoT and Expansion of Advance IoT.

Figure 3 shows the transition of 5G New Radio (NR) standard Release-15 to Release-17. Release-15 is focused on extreme mobile broadband. Release-16 will be focussed on the Industrial Internet of Things (IoT) in the year 2022 [6]. Release-17 is focused on advanced IoT and the expansion of mobility [7].

Table 1. Features/Characteristics of 5G Technology.

S. No.	Characteristics parameter	Value
1	Bandwidth	100 Mbps
2	Frequency Bands:	Low (600-850 MHz) Mid (2.5-3.7 GHz) High(25-39 GHz)

3	Download Speed:	Low Freq. Band (30-250 Mbps) Mid Freq. Band (100-900 Mbps) High Freq. Band (Gbps)
4	Small Cell area	10m-100m
5	Latency (Delay)	< 1ms
6	Energy Efficiency	High
7	Integration of IoT	yes
8	Mobile Phone Models Supporting 5G	Samsung S-20, Apple iPhone 12

3. Massive MIMO

In 5G networks, the outdoor and indoor scenarios are considered as different scenarios. To reduce the propagation loss in Indoor Communication we use a massive MIMO (Multiple Input Multiple Output) system [8]. It requires a combination of antenna expansion and complex algorithms. It can also ease carrier aggregation in 5G [9].

4. Beamforming

In 5G network beamforming is used. Beamforming is used to direct radio waves in a particular direction [10]. This technique uses combines the power from antenna arrays in a specific direction. It is used to improve the signal quality in a specific direction. It is of the following types: Digital Beamforming, Analog Beamforming and Hybrid Beamforming.

5. Multiuser MIMO (MU-MIMO)

It allows multiple users to share the same network resources which allows a faster and more efficient system [11].

6. Software defined networking (SDN)

Software defined networking (SDN) is set to be an integral part of the proposed 5G networks [12]. Software defined characteristics are assets for any modern network. It provides clear functionalities of different layers. Proper control and management is provided through framework for the whole network. Through flexible and programmable network components, flexible and optimized resource allocation is possible.

7. Research Issues in 5G Technology

There are practically many research issues in the design and implementation of 5G networks in India. Some of them are listed below:

- Frequency Bands
- Deployment and Coverage
- Device Support
- Security and Privacy
- Small Cells for High data rates
- Heterogeneous Networks
- New Carrier type
- Multiple Radio Access Techniques
- Massive Multiple Input-Multiple Output (MIMO)
- Machine to Machine Communication
- Artificial Intelligence for 5G networks
- Milli meter wave system

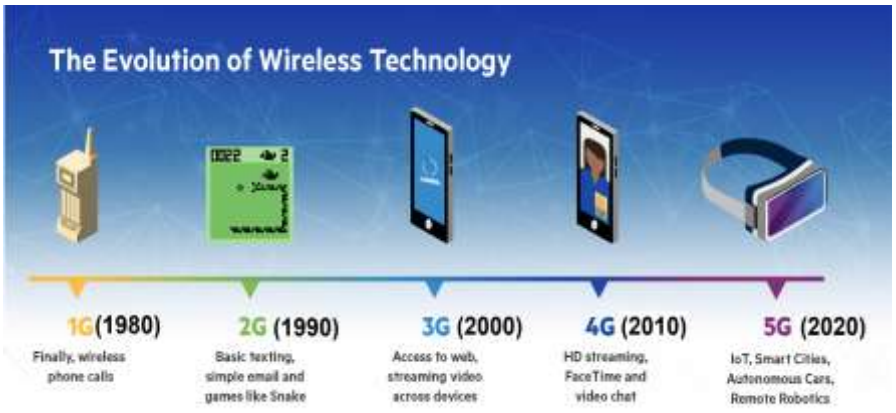

Figure 4. Year-wise Evolution of 5G Cellular Networks Technology.

8. Evolution of 5G technology

In figure 4, the evolution of 5G wireless cellular network technology from 1G to 5G is shown. Mobile technology was started in the year 1980 called the first Generation (1G). Now in 2020, we have reached fifth-generation (5G) technology. In the year 2020, the 5G was developed and implemented in many countries like the USA, China, and South Korea, etc.

9. Conclusion and Future Work

In this paper, we have discussed the key research challenges of 5G technology. The 5G network service was started in the year 2020 in many countries like China, the USA, and Korea. In India, 5G is yet to be started. For 5G implementation, the research challenges are faced by the network engineers like massive MIMO, Beamforming, etc. In the future, 6G is currently under development for wireless cellular communication in the range of 100GHz - 3THz.

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