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5G TECHNOLOGY – THE FUTURE OF MOBILE COMMUNICATION NETWORK: A REVIEW

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ABSTRACT

Here, we are discussing about a new mobile network technology i.e. 5G technology. Every 5 years or, a new technology is introduced in the market to integrate the life with more intelligent mobile technology. The first mobile networks appeared in the 1980s, GSM followed in the 1990s, 3G arrived in 2000s and 4G came out in 2010s. 4G is a very popular technology nowadays with 5G Fifth Generation yet to come. This new mobile network generation (5th) is expected to be operational in 2020s. It is a major phase of mobile technology standards that will provide a unique and more stable experience to its users. This paper provides an overview of 5G technology features, research and developments going to enable 5G technology. It highlights the salient features to ensure the next generation mobile technology (5G) as the leading network technology for the global communication.

Keywords- 5th Generation, Mobile technology, Network Standards.

Introduction

Digital wireless communication systems are growing since the launch of the analogue cellular system in 1980s. 5G technology comes after the evolution of 1G, 2G, 2.5G, 3G and 4G. 5G simply stands for fifth generation and refers to the next and newest mobile wireless standard based on the IEEE 802.11ac standard of broadband technology. The term 5G is used to describe the futuristic wireless communication technology after 4G (LTE), although this term is not a formal standard for 5th Generation technology. In this article, we describe the 5G technology with evolution from previous technologies, its features, architecture, advantages, developments and future scope.

Evolution from 1G to 4G

1G Technology

First generation system was launched by NMT (Nordic Mobile Telephone) in 1981. 1G was Analog technology, and supported the voice services only. It used the circuit switching and speeds up to 2.4kbps.

2G Technology

Second generation System came in the late 1980s. It is a digital technology used for voice and data services. It uses speeds up to 64kbps (GSM).

- Frequency Band –
 - o 850 - 1900 MHz (GSM) and divides each 200 kHz channel into eight 25 kHz time-slots.
 - o 825 – 849 MHz (CDMA). It divides each channel into nominally 1.23 MHz wide

2.5G Technology

2.5 generation system was developed in the 2000-2003. It uses 850-1900MHz frequency. It uses data rate of 115 kbps (GPRS)/384kbps (EDGE). Packet switching is used for the data transfer. Multiplexing techniques used are GPRS (GMSK-Gaussian minimum shift keying) and EDGE (8-psk). It provides different services like push to talk, MMS, SMS, mobile games, web based info entertainment, email access, video conferencing and support WAP multimedia.

3G Technology

Third generation system was developed in 2000 use W-CDMA/FOMA technology. 3G has transmission speed from 125kbps to 2mbps. It provides different services like global roaming, high voice quality and high data rates. The 3G aims at high data rates. ITU (International Telecommunication Union) defined 3G in international telecommunication (IMT)-2000 to provide high data transmission at low-cost, greater voice, high data capacity, support diverse

applications. It uses circuit switching for Voice calls. It use frequency of about 8 to 2.5 GHz and bandwidth of 5-20 MHz

4G Technology 4G system was initialized in the year 2010. 4G technology is all IP based network to provide high quality, high security, low cost services for voice and data services, multimedia and internet over IP. It introduced the new radio interface known as Evolved UMTS Terrestrial Radio Access (E-UTRA) and new packet –switching based core network called as Evolved Packet Core (EPC). This IP-based network architecture, allows for seamless handovers for voice and data to GSM, UMTS or CDMA2000 technology. It provides speed up to 100Mbps.

5G Technology

However still no transnational 5G development projects have officially been, launched. Predecessor technologies have occurred on the market a few years before the new mobile generation. If 5G families of standards were to be implemented, it would likely be around the year 2020, according to some sources.

The most important elements in 5G are mentioned below

- High increased peak bit rate
- Better connectivity to geographic region
- Lower infrastructural cost development
- High communication reliability
- Low battery consumption
- Support large number of devices
- High capacity to connect more devices concurrently and instantaneously
- High bit rate
- Increased scalability

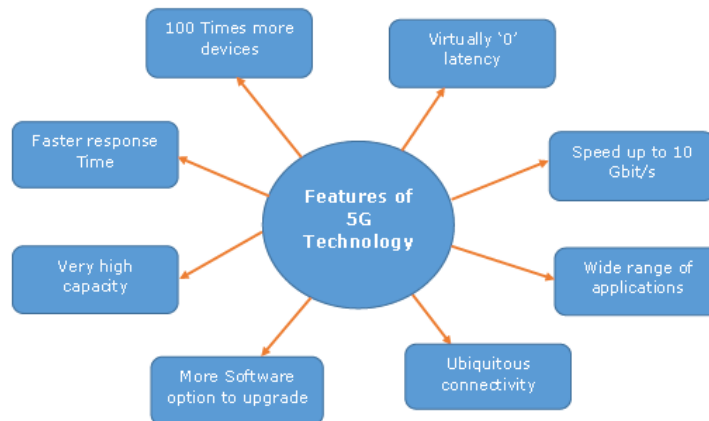


Figure 1: Elements of 5G Technology

The main need for 5G is the need for more bandwidth and low latency. Latency depends on processing speed of every node related to the data streams. Throughput depends upon the actual data transfer rate. When technology advanced from 2G gsm to 3G UMTS allows the real time video calls. LTE allow enhanced network capacity and reduced delay in services. 3G was first mobile broadband standard followed by 4G network. 2G was first digital mobile voice communication standard with wider coverage. The data rates have been improved with every generation. 5G is expected to have high transmission data rates with enhanced scalability, connectivity, energy efficiency of the network. It is assumed that 5G will come in existence by 2020 with 50 billion devices will connect to the global IP network.

Applications of 5G

Some of the applications of 5G network are:-

- It will facilitate people to use radio signal at high altitude.
- 5G application will make real world Wi Fi zone.
- The IPv6 technology will make the mobile IP address assigned as per connected network and geographical position.
- Availability of network will be everywhere and will provide people to use their computer and mobile devices anywhere anytime.
- Unified global standard for all.
- Will provide different version of radio technologies for sharing of spectrum efficiently.



Figure 2: Applications of 5G

5G Advancement

5G have the following advancement in comparison to the previous technologies –

- Super speed possible- 1 to 10 Gbps.
- Latency – 1 millisecond.
- 1000x bandwidth per unit area.
- Worldwide coverage.
- Longer battery life.
- Feasible connection to 10 to 100 number of devices.
- Whole world will be Wi-Fi coverage.

5G Advantages and Disadvantages

It offers a huge range of features beneficial for all group of people including students, teachers, engineers, governing bodies etc.

Important Advantages

- High resolution
- More efficient and effective network
- Easily integrate with previous technologies
- Provide uniform, consistent connectivity and uninterrupted connectivity across the world.
- Bi-directional large bandwidth
- Facilitate supervision tools for quick action
- Support heterogeneous services

Some other advantages for common people-

- Controlling PC by handset

- Easy education
- Easy medical treatment
- Easy monitoring record by various system related to criminal action.
- Visualizing planets, galaxies and universe will be possible.
- Easy Searching and locating

Disadvantages of 5G technology

- It is still under process and research is going on
- The claiming speed of this technology seems difficult to achieve because of the incompetent technological support in most parts of world
- Security and privacy need to be solved
- High Infrastructure cost
- This technology must be competent with previous with old devices

Need for 5G technology

Internet Data Speed- It is expected by analyst that by the year 2020, each person will have use 5G.

There will be approximate 51 billion devices connected worldwide like tablets, smart watches, tablets etc. Requirement of high speed access to the internet for users will be easily given by the 5G technology. The 5G system will provide bandwidth accordingly to the services requirement.

Millimeter Wave Communication- Additional Frequency bandwidth will be required to satisfy the new traffic and technology services, it should be greater than the 4G network. For this, millimeter wave frequency band is used to overcome the problem of rare spectrum.

Technologies behind 5G network

5G technologies will be built upon existing wireless technologies (GSM, LTE, HSPA, Wi-Fi) and new technology i.e. RAT (radio access technologies). Therefore, it comes up with the new idea of using millimeter wave frequencies that lies between 3 to 300 MHz, this is greater than today's network frequency. This frequency range is securely used by other broadcast technologies. Therefore, more speed and data will be available for network usage. The Millimeter range frequencies cannot pass through solid objects easily therefore, 5G network will use little range of base stations because of less stability in network for long distance. Smaller base station can share data with one another and also with everyone's phone.

5G-Architecture

5G Architecture is highly advanced, its network elements and various terminals are characteristically upgraded to afford a new situation. Likewise, service providers can implement the advance technology to adopt the value-added services easily.

Upgradeability is based upon cognitive radio technology which have various significant features such as ability to identify their geographical location or weather, temperature, etc. Cognitive radio technology acts as a transceiver (beam) that perceptively can catch and respond radio signals in its operating environment. Further, it promptly distinguishes the changes in its environment and hence respond accordingly to provide uninterrupted.

For wireless and mobile network, the system model of 5G is entirely IP based network. The system consists of main user terminal and then a number of independent and autonomous radio access technologies as shown in figure below.

Architecture Of 5G Technology

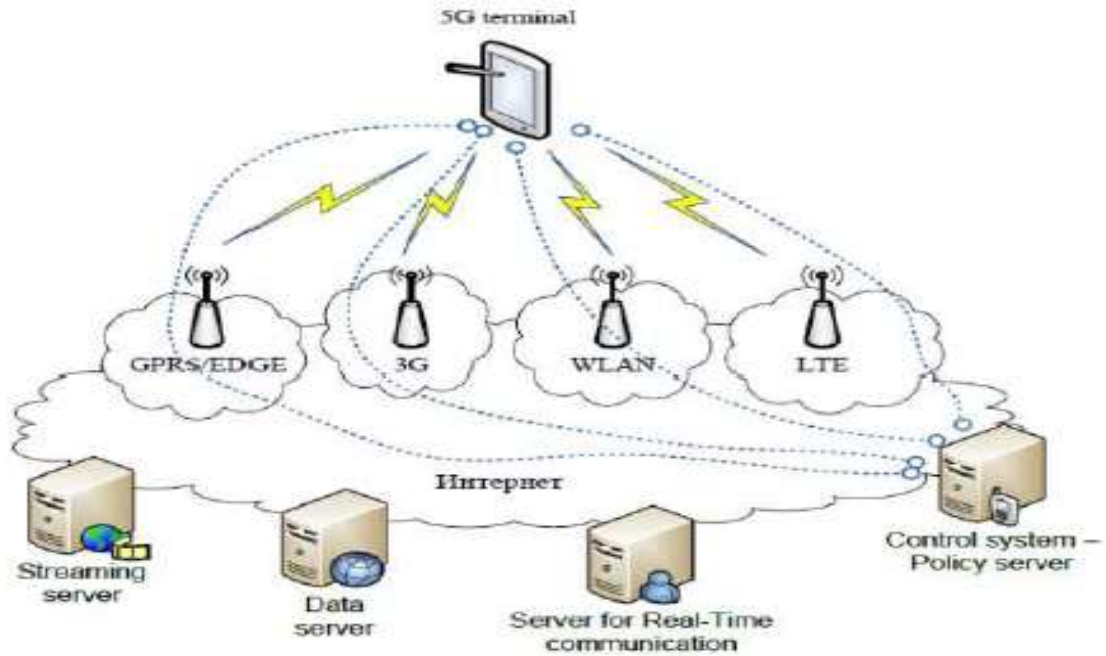


Figure 3: Architecture Of 5G Technology

Each radio technologies is considered as IP link for outside internetworld. The IP technology is designed exclusively to ensure sufficient control data for appropriate routing for IP packets related to a certain application connections. Moreover, packets routing should be fixed accessible to make accessible with the given policies of the user.

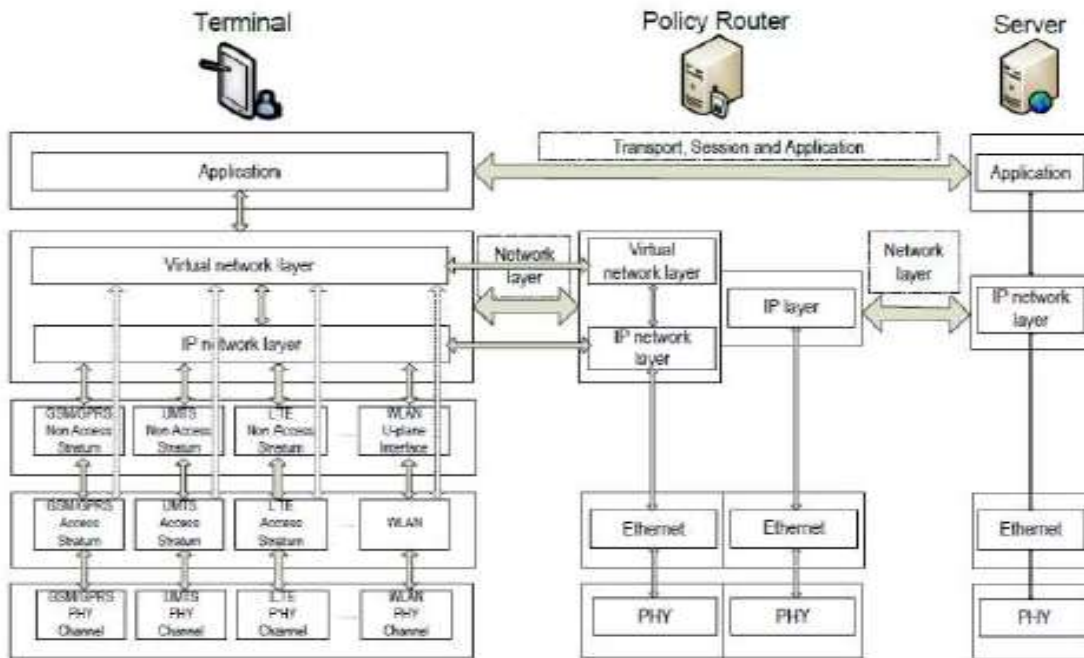


Figure 4: Routing of 5G Technology

The Master Core Technology

For other technologies the 5G mastercore is convergence point, which have their own impact on existing wireless network. To get operated into parallelMultimode including all IP network mode and 5G network mode. In this mode, it controls all network technologies of RAN and different Access Network (DAT). The technology is compatible and manages all the new deployment, it is more efficient, less complicated and more powerful.

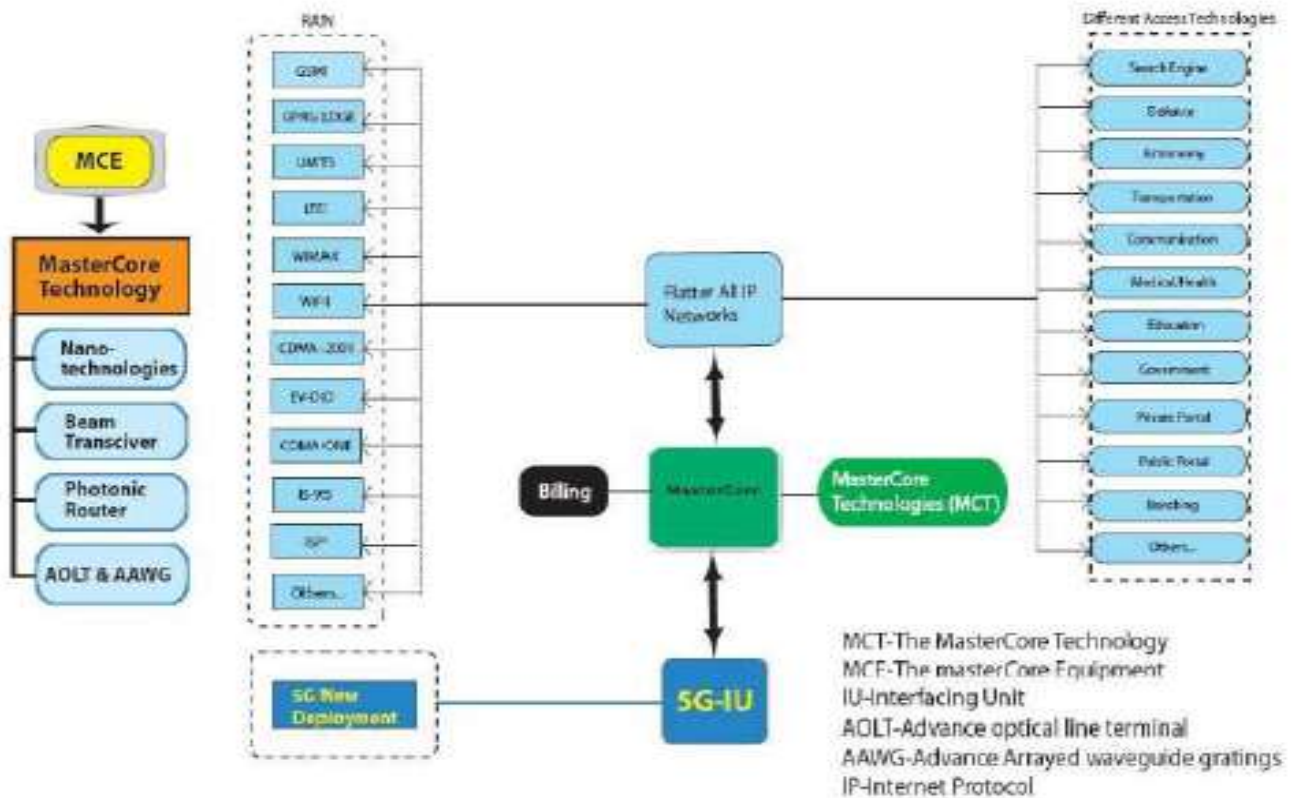


Figure 5: Master Core Technology

Surprisingly, by WCSM (World Combination Service Mode) any service mode can be opened under 5G new deployment mode. A wonderful feature of this technology is WCSM like if a teacher writes on white board in a country it can be displayed on any parts of world on another white board besides conversation and video. Further, through parallel multimode service new services can be easily added.

5G Modulation Schemes

Modulation schemes used in 3G and 4G include PSK and QAM. These schemes gives excellent spectral efficiency and have enabled very high data rates to carried but fall short in terms of their peak to average power ratio. To reduce PAPR issue, one option being considered for 5G modulation scheme is amplitude shift keying(ASK). As noise effect more on signal amplitude components, it is likely that any overall 5G modulation schemes will be adaptive, make system to switch to most optimum for modulation for given situation.

APSK- It is a digital modulation schemes that use amplitude and phase changes in accordance with the carrier (RF carrier). It has advantages that constellation diagram can be adjusted to optimize the signal mainly in terms of reducing peak to average power ratios. APSK has many advantages in terms of reducing PAPR, it may be used as one option in overall adaptive modulation schemes.

The modulation schemes will play a major role for 5G in determining the complexity and performance of handset and other nodes used. The 5G modulation schemes performance including peak to average power ratio, spectral efficiency and performance in the presence of interference and noise need to be included in any decisions made.

Peak to Average Power Ratio(PAPR)

For any 5G modulation schemes, it is one aspect of performance that needs to be considered. It has major impact on efficiency of power amplifier for 2G, the signal level was constant and therefore possible to use RF amplifier in comparison to obtain a high level of efficiency and maximize the battery life.

For 3G, its HSPA enhancements and then 4G, the modulation schemes and waveforms have meant that the signals have become progressively peaky with higher level of peak to average power ratio. Therefore, final RF amplifier can't run in comparison and as PAPR has increased, so the efficiency of RF amplifier has fallen and therefore, it is one factor that has shortened battery life.

The opportunity now arises to utilize 5G modulation schemes so that can reduce the PAPR and therefore improves efficiency.

Spectral Efficiency

With any form of 5G modulation scheme, one of the key issues is the spectral efficiency. It is essential that any modulation schemes adopted for 5G must provide a high level of spectral efficiency as with spectrum being at a premium, especially in frequencies below 3GHz.

Higher order modulation schemes need to need to be used when there is good signal to noise ratio. Therefore, any 5G modulation scheme under a variety of conditions will need to accommodate high level of performance.

5G Multiple Access Schemes

Multiple access schemes for 5G generation wireless or cellular telecommunication have been developed. 5G multiple access is being used carefully considered and research to ensure that optimum technique or techniques are adopted. 5G multiple access schemes are being considered by several candidates. They include different variety of ideas.

OFDMA-Orthogonal FDMA

OFDMA has widely and successfully used in 4G and could be used as a 5G multiple access schemes. However, using OFDMA and requiring orthogonality between carriers and using cyclic prefix has some drawback. As a result other multiple access techniques are being investigated.

SCMA- Sparse Code multiple access

Another multiple access considered as a 5G multiple access schemes. It is effectively combination of OFDMA and CDMA a carrier or carriers allocated to a given user normally with OFDMA. If spreading code added with each carrier, then it would be able to transmit data to or from multiple users. This technique is called Sparse Code and therefore significant no of users can be added while maintaining the spectral efficiency levels.

NOMA- Non-Orthogonal Multiple Access

It is one of the techniques being considered as 5G multiple accesses. This technique superposes multiple users in power domain and use cancellation techniques to remove the more powerful signal. NOMA can use orthogonal FDMA, OFDMA or the discrete FT, DFT-spread OFDM.

Many multiple access schemes can be used with 5G technology. The one or ones used will be chosen as a result of standardization process which is currently ongoing.

5G Specifications

The parameters have not defined by standard bodies to meet a 5G performance level yet, other organizations have set their own aims that may influence the final specifications. 5G standard typical parameters may include having network

of 10,000 times capacity of current network with peak data rate of 5Gbps. The latency may be <1ms and cell edge rate 100 Mbps. These are some of the ideas for 5G standard but they are not accepted by any official bodies yet.

CONCLUSION & FUTURE SCOPE

In conclusion with 5G technology mobile communication survey, it is designed as open platform on different layers from the physical layer to application layer. The Present network offers best operating system with less service charges. Lots of changes are done from one generation to next generation in wireless network. This upcoming 5th generation technology is very efficient and less expensive with lots of expectations. The future 5th generation technology will give high resolution for use of mobile phone users.

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