

## The 5th Generation Mobile Wireless Networks- Key Concepts and Challenges

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**Abstract-** Fifth generation mobile networks or 5th generation wireless systems, abbreviated 5G, are the proposed upcoming telecommunications standards beyond the current 4G/IMT- Advanced standards. Along with faster peak Internet connection speeds, 5G planning aims at providing higher capacity than current 4G, allowing higher number of mobile broadband users per area unit, and allowing consumption of higher or unlimited data quantities in gigabyte per month and user. 5G is considered as beyond 2020 mobile communications technologies. This upcoming technology will support IPv6 and flat IP. This paper addresses an overall description of the 5G systems and its architecture, standard, benefits, challenges in deployment, Security issues and scope of 5G technologies. This paper will also focus the researches being made on worldwide wireless web (WWWW), Dynamic Adhoc Wireless Network (DAWN) and real wireless world.

**Index terms-** 5G,4G-IMT, AIPN, DAWN,WWWW

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### I. INTRODUCTION

The use of internet supplemented with global mobile revolution has completely changed the way of working, thinking and interaction. Currently the 4G's concept is reaching towards the saturation phase. Now the time has come to introduce a new technology in which can connect to multiple wireless technologies, networks, terminals and applications, all simultaneously and can also switch between them. This latest technology would be called as 5G. The process of communication has undergone a number of changes. The technology creation, revolution and evolution of the wireless mobile had started since the early of decade of 1970. In the evolution process of communication system, cellular telephone began as a small step. Due to continuously increasing demand for cellular services, cellular telephone systems evolved in to complicated networks and internet comprised of several types of cellular communication systems. The application of the cellular concept in some full-duplex systems is standard cellular telephone services (CTS), personal communications systems (PCS), and personal communication satellite system (PCSS).

Initially the technologies like frequency modulation (FM) and frequency shift keying (FSK) were used in cellular communication system. FM was used for voice and FSK was used for transporting controlling and signaling information. Now a days some advanced digital communication techniques like Quadrature phase shift

keying (QPSK), Minimum shift keying (MSK) are used in wireless cellular communication system and also some new frequency bands has been assigned by Federal Communication Commission (FCC). Currently, the use of landline phones has reduced drastically and the present era is of convergence. The word convergence denotes merging of technologies, domain and discrete IT systems. The basic part of convergence is digitization which is accomplished through Analog-to-Digital Converters (ADC).

The world of telecommunication has seen a lot of changes starting from 1G to 2.5G and from 3G to 5G in last few decade. 5G technology is on its way to reform the way by which most of the users access their handsets. 5G allows users to use their handsets with a very high band width such that broadband is always supported. This advanced feature is going to make it the most powerful and in near future it is going to be in a huge demand.

It is expected that the 5th generation wireless technology will be launched around 2020. As compare to 4G, 5G will give better response in various factors like energy efficiency, bandwidth, spectral efficiency etc. This paper, exploratory in nature based upon secondary data, evaluates the 5G technology and its application.

### II. EVOLUTION OF MOBILE COMMUNICATION

This section briefly outlines the evolution of mobile communication technology from First Generation to Fifth Generation (1G to 5G).

The First generation cellular system (1G) was analog telecommunications standards introduced in the 1970s. In 1G, the voice channel used frequency modulation and frequency division multiple access (FDMA) techniques. The major disadvantages of 1st generation wireless systems were poor voice quality, poor battery quality and large phone size. In the decade of 1980, the 2G was introduced. The 2G systems were digital and were oriented to voice with low speed data services. 2G used GSM technology (Global System for Mobile communication). It is a circuit switched, connection based technology, where the end systems are devoted for the entire call period. Therefore, it causes low efficiency in usage of bandwidth and resources. Generally GSM enabled systems don't support high data rates and they are generally unable to handle complex data like video. It was followed by 2.5G. Though the 2.5G was not an officially defined term rather it invented for marketing purpose.

3G stands for 3rd generation wireless system. It has the capability to handle complex data like video and also it supports high data rates. Generally 3G wireless systems use Code Division Multiple Access Technique (CDMA). The 3G technology adds multimedia facilities to 2G phones by allowing video, audio, and graphics applications. Apart from that, 3G promises increased bandwidth, 384 kbps in mobile, 128 kbps in a car and 2 Mbps in a fixed application.

4G stands for 4th generation wireless system. It has been deployed in many countries. In 2009 IMT-A specified the requirements for 4G standards. A 4G system is expected to provide a comprehensive and secure based solution to laptop and mobile devices such as internet access, gaming services and streamed multimedia. The technologies like Coded Orthogonal Frequency Division Multiplexing (COFDM), Multiple Input Multiple Output (MIMO) and link adaptation are used in 4th generation wireless system.

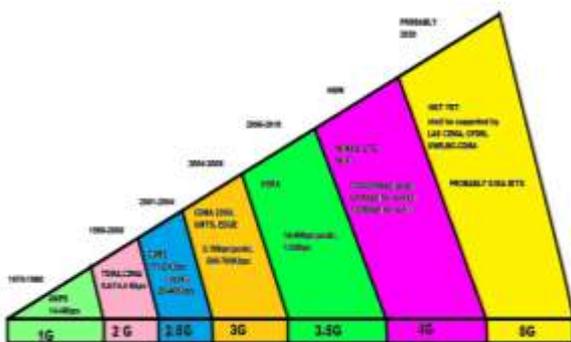


Figure 1: Comparison of various technologies [1]

The current research is going on 5th generation wireless system (5G). It is expected that, it will fulfill the entire requirement that has not been fulfilled by 4G such as quality of service which is less supported [4]. 5G technology has changed the means to use cell phones within very high

bandwidth. User never encountered ever before such a high value technology. All kind of advanced features which makes 5G technology most powerful and in huge demand in near future. 5th generation technologies which are on hand held telephone offering more power and features with superior quality of service. A user can also attach their 5G technology cell phone with their Laptop to get broadband internet access.

III NEED OF 5G WIRELESS SYSTEMS

From a user point of view, there are some major technological differences between present generations and expected 5G technologies: [2]

- 1) High data rates and better coverage area at the edge of the cell.
- 2) Low battery consumption.
- 3) Availability of multiple data transfer path.
- 4) High data rate around 1 Gbps in mobility.
- 5) More secure and better cognitive security.
- 6) High energy efficiency and spectral efficiency.
- 7) Low cost due to low infra structure and deployment cost.
- 8) World Wide Wireless Web (WWWW).
- 9) Less harmful to human health.

Due to the above advantages, 5th generation wireless system is very essential.

TABLE 1: TECHNOLOGY TRANSITION

GENERATION	TECHNOLOGY USED	DATA RATE
1G	FM,FDMA	2 KBPS
2G	TDMA/CDMA	14.4 TO64KBPS
3G	CDMA	2MBPS
4G	CDMA	200 MBPS-1GBPS
5G	CDMA	1GBPS AND HIGHER

IV FEATURES OF 5G WIRELESS TECHNOLOGY

Based on some research papers on 5G technology, the key concepts suggested for 5G beyond 4G are as follows: [3]

- Dynamic Adhoc Wireless Network (DAWN) combined with smart antennas and flexible modulation.
- Internet Protocol Version6 (IPv6), IP address is assigned according to location and connected network.
- Provides High altitude stratospheric platform station (HAPS) systems.
- No limitation for access and zonal issues so will become a Real wireless world.

- Instead of operator centric (as in 3G) or service-centric (as in 4G), it utilizes user centric network concept
- Suggests World Wide wireless web (WWWW) i.e. comprehensive wireless based web applications that include full multimedia capability beyond 4G speeds.

### V 5G ARCHITECTURE

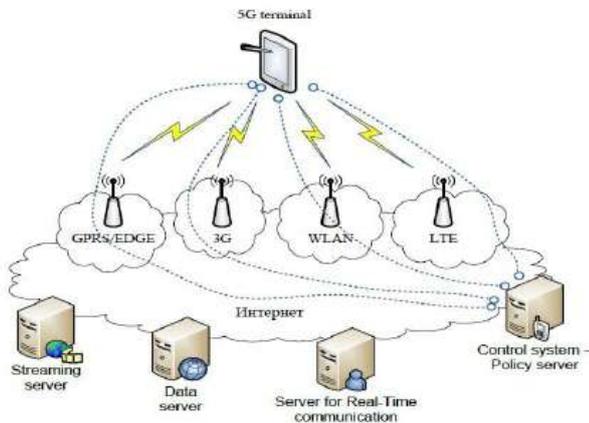


Figure 2 : Proposed architecture of 5G[5]

The all-IP (IPv6) is important feature of fifth generation wireless networks. It is capable of fulfilling increasing demands of cellular communication market. It provides a common platform to all radio access technologies. It provides optimized performance and cost by using packet switching. The 5G mobile architecture consists of all IP based mobile applications and services such as Mobile Portals, Mobile healthcare, Mobile banking, Mobile Government etc. These applications are offered via Cloud Computing Resources (CCR). CCR links the Reconfigurable Multi Technology Core (RMTC) with remote reconfiguration data from RRD attached to Reconfiguration Data Model. The core is a convergence of the nanotechnology, cloud computing and radio. It is based on all IP platform. RMTC is connected to different technologies from 2G/GERAN to 802.16x(WMAN). Due to interoperability process criteria, both terminal and RMTC can select from heterogeneous access systems.

### VI CHALLENGES FACED IN THE DEVELOPMENT OF 5G

Continuous evolution in cellular communication is facing the basic problem of limited available frequency spectrum. Every new generation of mobile communication is typically assigned a new frequency band and wider spectral bandwidth per frequency channel. But in current scenario, there will be little scope available for new frequency band and larger spectrums. The other possibilities include use of unlicensed spectrum or secondary spectrum i.e. the licensed

spectrum already in use. To overcome these limitations, 5G need to adapt following main technologies:

#### 1. Cognitive Radio Technology:

White space allows different radio technologies to use same spectrum efficiently by finding unused spectrum and adapting transmission technologies which ultimately depends on Software Defined Radio (SDR). SDR can develop multi band, multi standard base stations and terminals to increase network capacity. This is achieved by reconfiguring the network by adding several modems at a base transceiver station (BTS).

#### 2 Nanotechnology:

Nanotechnology is the application of nanoscience to control process on nanometer scale; between 0.1 and 100nm, also known as molecular technology. Nanotechnology will have considerable impacts on 5 g mobile device and the core network.

The mobile device is no longer remain only as a communication device in modern communication industry, but with use of nanotechnology, intelligence and embedded systems, it will also provide a platform to serve applications in various fields like transportation, medicine and safety.

To provide interoperation of different heterogeneous access technologies, the core network should have high speed and reliable capacity. At present, use of nanotechnology in digital signal processing (DSP) fabrications, provides higher speed and capacity.

#### 3 All IP Network:

The All IP Network (AIPN) is an evolution of 3GPP system to fulfill increasing demands of cellular communication market. It is a common platform for all radio access technologies which includes criminals and viruses along with developers. Looking at such imminent threat of cyber criminals and viruses, the security issues pertaining to the technology need to be solved properly and at earliest. AIPN provides different access systems at lower costs and reduced system latency.

#### 4. Cloud Computing:

Cloud Computing is a model for enabling ubiquitous, convenient, on demand network access to a shared pool of configurable, computing resources (e.g. networks ,servers, storage, applications ,and services )that can be rapidly provisioned and released with minimal management effort or service provider interaction. Hence 5G is a technology that uses internet and central remote server to maintain data and applications. In 5G networks, cloud computing can allow consumers and business to use applications without installation and access their personal files at any computer with internet access. Thus cloud computing as a global central server becomes a content provider for 5G technology.

### 5. Internet of Things-IoT:

The 5G technologies with high rate of data transfer at lowest cost will enable Internet of Things. (IoT) According to Cisco IBSG (2011) [6], there will be 50 billion connected devices to the Internet. These devices which are embedded with day to day systems will convert Data to Knowledge and finally to Wisdom, that will be useful in the areas such as healthcare, communication, education, public utilities and in would be smart cities. The IoT will surely going to revolutionizing human life. The sensing devices will transmit the data which will be analyzed for decision making. IoT will leads to analytics which will enhance the existing knowledge and wisdom. For the effectiveness of IoT it is important to transfer data at very high speed. The 5G technology will not only transfer the data at higher but also initiate next level of evolution of the internet.

- [6] Dave Evans," The Internet of Things-How the next evolution of the Internet is changing Everything", CISCO IBSG White Paper, April 2011.

### VII CONCLUSION

The paper is focused on a review of evolution of cellular mobile communication starting from 1G to 4G based on important parameters such as radio access, data rates, bandwidth and switching schemes. It determines the need for 5G mobile communications to meet the requirements of current cellular communication industry. The paper focuses on building reconfigurable mobile system to overcome the limitations of limited available frequency spectrum and the need to accommodate continuously increasing number of users with latest technologies such as cognitive radio, AIPN, nanotechnology and cloud computing. With all these advanced features, 5G technology will be most powerful and in huge demand in near future.

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