

Features Analysis and Comparison of 5G Technology: A Review

Uvika Kujur
Dept. of Computer Science
Dr. C.V Raman University,
Bilaspur (c.g), India
Mob. 8962195882

Dr. Ragini Shukla
Dept. of Information Technology
Dr. C.V Raman University
Bilaspur (c.g) India
Mob.8319798167

Abstract – *The main objective of this paper is a detailed and comprehensive study about the evolution of the various mobile generation technologies in the wireless communication. The paper deals with evolution of mobile generation which helped in developing 5G technology of mobile and communication. This paper also discussed about the countries which are using and testing 5G technology, as well as the companies which have undertaken the development of 5G. The 5G technologies include all types of advanced features which make 5G technology most dominant technology. This paper overview of key enabling technologies which could be used in future 5G wireless systems. Some of these are Massive MIMO, Device-to-Device (D2D) communications, and Millimeter wave communications.*

Keywords: 5G, wireless communication, MIMO Antenna, spectrum, D2D, Millimeter wave

I. INTRODUCTION

Mobile wireless industry has started its technology creation, revolution and evolution since early 1970. From Mid 1990's the cellular communication industry has witnessed explosive growth. During the past decade, the volume of mobile data traffic has increased at a rapid pace and quantitative studies predict that the exponential growth will continue in the future. Wireless communication plays a significant role in day to day life, besides communication wireless technology has become an integral part of our daily activities. The transmission of data or information from one place to another wirelessly is referred as wireless communication. In wireless communication, the most common means of signal transmission is to modulate the information signals by the high carrier frequency. Wireless technology offer e-commerce more flexible and in-expensive ways to send and receive data, this technology is one of the most active areas of technology development of our time. Wireless networks are computer networks that are not connected by any kinds of cable. Wireless networks use radio waves to connect devices such as laptops to the Internet, the business network and applications. When laptops are connected to Wi-Fi hot spots in public places, the connection is established to that business's wireless

network. This network is getting popular nowadays due to easy to setup feature and no cabling involved. Wireless LANs operate in almost the same way as wired LANs, using the same networking protocols and supporting the most of the same applications. They offer performance that are differ from wired LANs, unique security considerations and specific interoperability requirements.

5G hasn't been released yet, so we can't comment on real-world experiences, but it's been estimated that 5G will provide everyday download speeds of 100 Mb/s, at a minimum. 5G is not just a mobile technology, it is ubiquitous access to high & low data rate services. 5G research and development also aims at lower latency than 4G equipment and lower battery consumption, for better implementation of the Internet of things[4]. This will be designed to support a variety of applications such as the IoT, connected wearables, augmented reality and immersive gaming. This technology will offer the services like Documentation, supporting electronic transactions (e-Payments, e-transactions) etc.

II. LITERATURE REVIEW

A number of researchers have worked in this field. A short resume of development in this field has been given below:-

Some researchers have focused on 5G based wireless technology mobile network, security, remote control robots. In this context Janevski, et al. (2009), have also described about IPv6 and flat IP architecture which is necessary for the development of 5G, also indicates the growth in mobile generations from 1G, 2G, 3G, 4G, 5G.

Bhalla M. R, .et al.(2010), have throw light on the evolution and development of various generations of mobile wireless technology along with their significance, portals, performance, advantages and disadvantages of one generation over the other. They have also discussed about the HSDPA (High-speed download packet access) and HSUPA (High-speed upload packet access).

Sapakal S.R. et al. (2013), have discussed about the comparison of all generation of mobile technology and elaborated the needs of 5G, and have drawn 5G

network architecture. Also focuses on all preceding generations of mobile communication along with Agyapong .P.K .et al. (2014), have presented an architecture vision to address the challenges placed on 5G mobile networks. They also discussed about the 5G challenges, Enablers and design principle and mobile network architecture vision.

Olumuyiwa O.F., (2014), has compared all the 3G, 4G and 5G networks and advantages of 5G communication system as a future preferred networks, threats of 5G implementation and comparative study on 3G, 4G and 5G wireless technology.

Mamur.A.et al. (2016), have discussed the technology evolution trends seen from 1G to 4G mobile communication. They also go through the needs for the 5G technology expected in 2020. A detailed functionality based architecture and Prospective features of the 5G technology are mentioned.

Singh .S.P, (2016), has observed that due to the application of packet switching, speed of internet becomes higher. The application of orthogonal

fifth Generation technology.

frequency division increases the bandwidth increases.

Rathee .A .et al. (2017), have discussed about the modern era the exponential growth in smartphones with better applications need higher efficiency as compare with 4G devices, and also an overview of key enabling technologies which could be used in future 5G wireless systems. Some of these are Massive MIMO, Device-to-Device (D2D) communications, full duplex technique, millimeter wave communications. An investigation of available key techniques for 5G underlying LTE network is done, these techniques have huge potential to increase the channel and spectral capacity.

Singh R.K .et al. (2017), have focused on all foregoing generations of mobile technology, developmental aspect of 5G technology and basic architecture/concept behind this mobile technology. And also on 5G mobile technology and these researches are mostly related to the development of World Wide Wireless Web (WWW) and Dynamic Adhoc Wireless Networks (DAWN).

III. METHODOLOGY

In this paper the following Methodologies are adopted to achieve the objective the architecture of this technique showing in Fig.1 which have used in our research work.

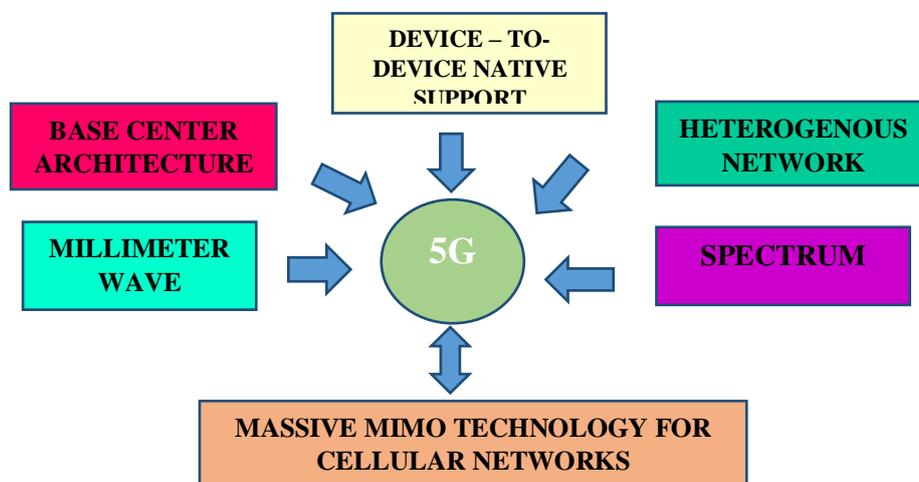


Fig.1 Integration of various emerging technologies towards 5G wireless system

MIMO—Other new concepts for 5G networks include massive MIMO (Multiple Input Multiple Output), ultra dense network, and a huge number of connected devices known as machine-type communication. MIMO implies multiple-input and multiple-output and is used by combinations of multiple transmitters/receivers or antennas at both sides of digital communication systems [2]. MIMO antenna arrays are currently in use, but generally only have a few antennas. MIMO arrays contain

multiple antennas which can be used to beam shape and direct transmitted signals (and obtain received signals) in a specific direction. The massive multiple-input multi-output (MIMO) antenna technology is validated to improve 10 to 20 times the spectrum efficiency in the same frequency bandwidth [5]. This can be used to directly meet the goals of 5G by increasing the data rate and decreasing latency. It also indirectly meets the goals by allowing the millimeter wave frequencies

to be practically useful despite their characteristics of high attenuation and low diffraction. In wireless communication system this method is used to increase the capacity of channel in radio link by using multiple transmit and receive antennas. In past the prime focus is on point to point MIMO where two devices communicate with each other with multiple antennas [6].

MILLIMETER WAVE – 5G NR mmWave is emerging as a key technology that could define the next big moment in the mobile industry, ushering in the next generation of user experiences and significantly increasing network capacity. Higher spectrums in the ranges of GHz and THz could be deployed by utilizing techniques in cognitive radio [2]. mmWave bands have been utilized for quite some time in fixed, line-of-sight wireless communications for fixed wireless backhaul and satellite communications, increased propagation loss, susceptibility to blockage (e.g. hand, head, body, foliage, building penetration), 5G NR based mmWave is changing this, and Qualcomm is leading the way.

BASE CENTRE ARCHITECTURE –

For 5G evolution the base centric architectures would have major role to play in wireless communication. The up-linking and downlinking concepts must be integrated to data wireless channels for better servicing of data flows with different priorities towards nodes set within wireless network. By use of base centric design both control and traffic signals are transmitted under same downlink and its corresponding uplink connection for more denser networks in future some vital changes must be done to 5G.

DEVICE TO DEVICE COMMUNICATION –

The D2D communication in cellular networks is defined as a point to point radio technology in which communication between two devices are done without the utilization of BS. This generally operates on both licensed spectrum and unlicensed spectrum i.e inband or outband spectrum [3]. D2D communications will reduce communications between devices and base stations and data center and all of their associated overhead will be reduced with it. In device level communication the base station i.e. have full or partial control over relaying device and resource allocation of source and destination [4].

SPECTRUM– More spectrum means more network capacity, which means faster data rates and better user experience. Opportunities for more spectra include higher frequency bands (e.g.,

millimeter-wave, mmW), unlicensed spectrum, and aggregation of fragmented spectrum resources using carrier aggregation techniques. The significance of spectrum sharing is probable to increase, dedicated licensed spectrum access is expected to remain the baseline approach for mobile broadband which provides reliability and investment certainty for cellular mobile broadband systems.

HETEROGENEOUS NETWORK –

Heterogeneous system or a heterogeneous network is considered as a unified network [7] and access a single segment which will place the connection with the application servers in and out of operator's network. In heterogeneous wireless networks the concept is "always best connected" (always associated with the best quality), aimed at client terminals, and is proposed in different researches. These network sets must provide full connectivity aspects of a given machine in session cellular approach.

IV. FEATURES ANALYSIS AND COMPARISON –

According to some research paper on 5G technology, we have found some of the features which are very supportable for development of 5G technology which are listed below:

- 5G technology offer high resolution.
- It provides advanced billing interfaces.
- The high quality services of 5G technology based on Policy to avoid error.
- 5G technology is providing large broadcasting of data in Gigabit which supporting almost 65,000 connections.
- 5G technology offer transporter class gateway with unparalleled consistency.
- The traffic statistics by 5G technology makes it more accurate.
- Through remote management offered by 5G technology a user can get better and fast solution.
- The 5G technology is providing up to 25 Mbps connectivity speed.
- This technology also support virtual private network.
- The new 5G technology will take all delivery service out of business prospect.
- The uploading and downloading speed of 5G technology will be 20 times faster than 4G.
- The 5G technology network offering enhanced and available connectivity just about the world.
- 5G technologies have an extraordinary capability to support Software and consultancy.

- It provides high connectivity as it uses router and switch technology.

Comparative study of various generations from 1G To 5G –

1G – 1G was developed in 1980s and completed in early 1990s, it was based on analog system. It provide speed upto 1 kbps, AMPS system was allocated a 40 MHz bandwidth within the 800-900 MHz frequency range by the federal Communication Commission (FCC) [9]. 1G has low capacity, unreliable handoff, poor voice links and no security. The first generation has fulfilled the basic needs of voice, while the second generation has introduced high capacity and vast coverage area [8].

2G – 2G was developed in late 1990s, in 1991 2G was launched in Finland. It is based on digital system, Second generation networks allow limited data support in the range of 9.6 kbps to 19.2 kbps. The bandwidth required for 2G transmission is about 20-200 KHz. 2G used digital encryption to improve security and packet switching to increase spectrum efficiency resulting in secure data transfer and better connectivity. 2G phones was developed which introduce the GSM technology, GSM uses digital modulation to improve the voice quality but the networks offer the limited data services. 2G continued to improve the transmission quality and coverage.

3G – 3G technology was invented in year 2000. The speed is 144 Kbps to 2Mbps and bandwidth of 5-20 MHz, it uses both the packet switching and circuit switching. It is based on the International

- In the 5G technology, World Wide Wireless Web (WWWW), wireless-based web applications.

Telecommunication Union (ITU) family of standards under the International Mobile Telecommunications programme, IMT-2000 [1]. Mobile offers access to broadband multimedia services, which is expected to become all IP based in future 4G systems. Services include wide area wireless voice telephony, video calls, and broadband wireless data.

4G – 4G was developed in 2000-2010, it uses the CDMA multiplexing and all packet switching. LTE is regarded as the 4G technology. WIMAX and LTE version support only less than 1GB/s peak bit rate. Both are not fully IMT-Advance, but are often branded 4G by service provider [11]. 4G can support at least 100 Mbps peak rates in full-mobility wide area coverage and 1Gbps in low-mobility local area coverage [10].

5G – Currently 5G terms is not officially used. This technology offer very high bandwidth that user never experienced before. This technologies also offers tremendous data capabilities and unrestricted call volumes and infinite data broadcast together within latest mobile operating system. Fifth generation is based on 4G technologies. 5G technology is considered as the most influential technology due to its advanced features [4]. It is designed to provide incredible and remarkable data capabilities, unhindered call volumes, and immeasurable data broadcast within the latest mobile operating system. Table 1 gives a detailed description about features like deployment, bandwidth, multiplexing, services and web standards. The services given were more priority as compared to its previous generation.

Table 1. Comparison of Various Generation

Technology	1G	2G	3G	4G	5G
Deployment	1970/1984	1980/1999	1990/2002	2002/2010	2015/2020
Bandwidth	2kbps	16-64 kbps	2mbps	200mbps	>1gbps
Technology	Analog cellular	Digital cellular	Broadbandwidth/ CDMA/IP technology	LAN/WAN/WLAN/PAN	4G+WWWW
Multiplexing	FDMA	TDMA/CDMA	CDMA	CDMA	CDMA

Service	Voice only	Voice and data	High speed voice, data and video Main Network: Packet Network	Dynamic information access, wearable devices, HD streaming, global roaming	Dynamic information access, wearable devices, HD streaming, any demand of users
Network core	PSTN	PSTN	Packet N/W	Internet	Internet
Frequency	824-894 MHz	850-1900 MHz	1.8 - 2.5 GHz	2 - 8 GHz	3-300GHz
Switching type	Circuit	Circuit	Packet and switch circuit	All packet	All packet
Handoff	Horizontal	Horizontal	Horizontal	Horizontal & Vertical	Horizontal & vertical
Location of first commercialization	USA	Finland	Japan	South Korea	San Marino
Standards	MTS AMTS IMTS	2G GSM 2.5G GPRS 2.75G EDGE	IMT- 2000 3.5G HSDPA 3.7G HSUPA	Single unified standard LTE/LTE Advance Wi-Max, Wi-Fi	Single unified standard
Web Standards		WWW	WWW(IPv4)	WWW(IPv4)	WWW(IPv6)
Shortfalls	Low capacity, unreliable handoff, poor voice links, less secure	Digital signals were reliant on location & proximity, required strong digital signals to help mobile phones.	Need to accommodate higher network capacity.	Being deployed	Yet to be implemented

Country wise comparative study of 5G technology –

In this research work we have reviewed various countries for 5G technology, and compared all that countries in case of 5G technology which is described below:

South Korea – South Korea is the first country to use 4G mobile technology. The development of 5G technology is a priority for the South Korean government. This country is seen as the most advanced market in terms of 5G development. In South Korea two service providers are vying to be first to make with a 5G network, SK Telecom has acquired spectrum in the 3.5 GHz and 28 GHz frequencies in anticipation of deploying 5G, and Korea Telecom made a splash in early 2017 with its announcement that it would roll out a trial 5G network ahead of the 2018 Winter Olympics in Seoul, South Korea. The trial network is expected to cover events in Bokwang, Gangneung, Jeongseon, PyeongChang, and Seoul [13].

China– China has started the third phase of 5G technology research and development tests, ahead

of schedule, as the Asian nation accelerates the process to commercialize next-generation telecom services. Phase included testing wireless technologies including massive multiple-input-multiple-output, novel multiple access, new waveforms, advance coding, ultra-dense network implementations and high-frequency communications. The trial phase also included network slicing, edge computing and network function reconstruction. Five companies including Huawei, ZTE and many more have built 15 base stations in Huairou District in Beijing to support further testing. China Mobile, the world’s largest mobile operator, previously said it aims to deploy 10,000 5G base stations across China in 2020. Operators participating in the IMT-2020 Promotion Group include China Mobile, China Telecom, China Unicom and Japanese telecoms operator NTT DoCoMo.

San Marino– San’s Marino would be the first in Europe using 5G networks. The state has little more than 30,000 citizens, extends to only 61 sq/km, making it the smallest republic in the world. Telecom Italia is also testing 5G in Milan and Turin but has more freedom in San Marino to

experiment because of fewer restrictions on the use of airwaves than in Italy. The European Commission published a 5G action plan last year when it estimated that sectors such as healthcare, transport, cars and utilities would see economic benefits by 2025 from technology. Telecom Italia has started working with companies including Maserati and Ducati on the use of better wireless technology.

India– India will get 5G much sooner, probably by 2020 or late 2019. Telecom giant Airtel and Huawei have conducted the first trial of 5G in India at network experience centre in Manesar, Gurgaon. During the test trial, a user throughput of more than 3Gbps was achieved using the setup [15]. This is the highest measured throughput for a mobile network in 3.5 GHz band with 100 MHz bandwidth and end-to-end network latency of approximately 1msec. The setup included 5G RAN operating on 3.5 GHz band, 5G Core and 50GE Networking Slicing router. Indian customers get 4G speeds of only 6.07 Mbps-10Mbps which is lower than the global average.

V. CONCLUSION

Thus, we conclude that 5G network is very fast and reliable, 5G networks are expected to satisfy rapid wireless traffic growth. Massive MIMO, millimetre wave communications and small cell technologies are presented to achieve Gigabit transmission rate in 5G networks. The 5G mobile phones will be a tablet PC. Many mobile embedded technologies will develop. A new revolution of 5G technology is about to begin because 5G technology going to give tough completion to normal computer and laptops whose marketplace value will be affected. The development of the mobile and wireless networks is going towards higher data rates and all-IP principle. It offers tremendous data capabilities and unrestricted call volumes and infinite data broadcast together within latest mobile operating system. This generation is expected to be released around 2020.

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