

“What to expect from 5G systems?”

Siddhant Dhawan¹, Varun Sharma²

¹(Electronics and Communication Engineering , Bharati Vidyapeeth’s College Of Engineering / Guru Gobind Singh Indraprastha University, India)

²(Electronics and Communication Engineering , Bharati Vidyapeeth’s College Of Engineering / Guru Gobind Singh Indraprastha University ,India)

Abstract: 5G is the advancement in communication beyond our expectation. It will correct the limitations of present day communication up to great extent. It will come with increased speeds (at least 1Gb/s), very less or zero transmission delays and many more as mentioned in paper . New protocols like VOICE over INTERNET PROTOCOL (VoIP) would make the whole world local by providing voice calling service over internet. 5G would not revolutionize the technological world only but it would be a great boom to economy .Hence by following this way 5G would be able to overcome the limitations of all G's . Another thing to be noticed that is that the 5G would not only be a success for human information interaction alone but it would also make machine type communication a great success. This generation of communication would actually give a feel of real time communication to the users as they would be able to enjoy such advanced and interesting features for low cost, once they have paid to upgrade to this technology.

Keywords: Cloud Services, E2E, IPv6, ITSs, LTE, MTC, RATs, VoIP , www

I. Introduction

Changes in any field are very crucial for its success and its dignity. But communication is one of the field that has shown its potential of success by rapid advancement right from 1G to 2.5G and from 3G to 3.9G (4G LTE) world of communication. The advancement of communication world communication like communication protocols now is more efficient than the previous one. Evolutions of all “communication generations” have drastic differences between them, summarised in fig. 1.

FEATURES	1G	2G	3G	4G	5G
Data Capacity	2 Kbps	10 Kbps	284Kbps to 2Mbps	2Mbps to 1Gbps	1Gbps & Higher
Standards	AMPS	CDMA TDMA GSM	CDMA/ WCD- WCD-MA/ UMTS/ CDMA 2000 3GPP	IP-broadband, LAN/WAN/ PAN and WLAN, 3GPP2	Single unified Standard will be formed by ITU-R WP 5D
Technology	Analog Wireless	Digital Wireless	CDMA 2000 (1xRTT, EVDO) UMTS, EDGE WIFI	LTE advanced IEEE 802.16m WiMAX MBWA system	mmWAVE and cmWAVE system MultiRAT Advanced MIMO IPv6, www
Spectrum	800-900 MHz	850-1900 MHz (GSM) 825-849 MHz (CDMA)	1.6-2.5 GHz	2-8 GHz	6-80 GHz
Multiplexing	FDMA	TDMA	CDMA WCDMA	CDMA OFDMA	LAS-CDMA OFDMA MC-CDMA BDMA
Switching	Circuit	Circuit, Packet	Packet	All Packet	All Packet
Core Network	PSTN	PSTN	Packet Network	Internet	Internet
Handoff	Horizontal	Horizontal	Horizontal	Horizontal and vertical	Horizontal and vertical
Services	Voice only	Voice data, SMS, MMS	Integrated high quality audio /video and data, Mobile internet	Dynamic information access and wearable devices	Dynamic info. Access, Wearable devices with AI capabilities, IoT

Fig.1. Comparison of 1G, 2G, 3G, 4G and 5G

Communication industry is combination of both existing and evolving systems. It includes some existing technologies like Wi-Fi and LTE advanced, coupled with new ones such as machine control and virtually zero latency. 5G will be next step in evolution of mobile communication. 5G is nothing but another expected advancement of communication systems that will make communication more efficient, secure, user

friendly and many more by overcoming the “limits” of current systems. Some of these features are referred in fig.2.

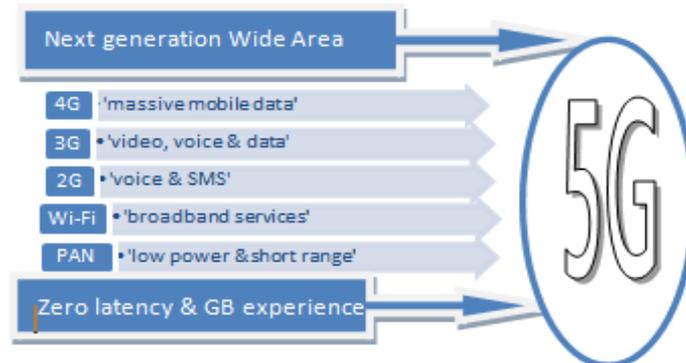


Fig.2. 5G: Integration of existing and new technologies

With the continuing development of LTE in a compatible way, definitely it will be a part of 5G wireless access solution for frequency bands below 6GHz. Voice over Internet Protocol (VoIP) is a methodology a group of technologies for the delivery of voice communication and multimedia sessions over Internet Protocol networks, such as the internet. Users will go through a level of volume of call and data transmission with 5G pushed over a VoIP enables gadget. [1],[2]

In parallel, evolving existing Radio- Access technologies (RAT's), like LTE will also be a part of future flexible and dynamic 5G systems. New technologies like virtually zero latency or very low latency and additional capacity requirement will make them to operate at higher frequency than they do today. Fortunately, most of the major players already investing and researching the next generation of wireless technology agree on a few key requirements, such as connection speeds up to 10 Gb/s -- 500 times faster than current LTE technologies -- and latency reduced to 1ms. Moreover, it needs to be secure, offering seamless and uninterrupted connectivity.

Since 5G will not only provide the good data capacity but also security and uninterrupted connectivity, it will be enabling a new range of services, both for consumers and enterprises, in areas like Internet of Things(IoT), e-health, smart homes, connected cars, and much more.

For example, 5G could allow instant telesurgery, making it possible for surgeons to operate surgery robots at long distance, something that requires almost zero latency and reliable links. It will also be critical for C2X (Car to Infrastructure communications), self-driving cars and remote management of self-driving trains. Consumers can expect a boost on their entertainment options, with extremely high-definition video (4K and 8K) and 3D coming to portable devices, and online gaming will reach new levels of realistic experience and immersion, with new devices delivering a new virtual reality experience at lower cost.

II. 5g-Requirements And Capabilities

Initially, cellular networks using analogue transmission channels were designed for voice applications. Then digital technology evolved, digital 2G systems emerged in the 1990s, enables text messaging and circuit switched data access. Low data rates services by 2G systems leads to demand for new 3G systems and more capacity for voice. The recent 4G mobile communication LTE was developed for high data capacity mobile multimedia. From historical point of view, each communication technology was developed around some key use cases mentioned as follows and referred in fig.3 [3]:

- 1G: Voice service
- 2G: Voice and SMS
- 3G: Integrated voice and affordable internet
- 4G: High capacity mobile multimedia

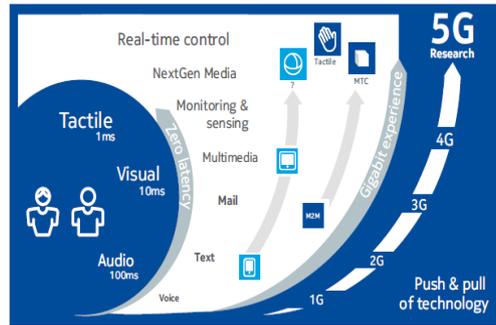


Fig.3. 5G Demands- higher capacity, low latency and more consistent experience [3]

An increase of data rates and virtually “Zero latency” needs are equally important. The next generation mobile communications will not be only for human interaction, instead we will see huge growth of IoT, which requires more reliable communication links but also at lower delays. However, lower latency will also be supported by new applications. Some of these applications are traffic safety, control of critical infrastructure and industry processes.

In addition to almost zero latency, 5G systems will be able to provide extremely high reliability and ultra-high availability in terms of connectivity. So the traffic issues of connectivity will be resolved.

There is strong need of “Gigabit experience” [3] which means data reception and transmission rates to users and machines. Higher capacity will require better performance and access to new, broader carrier in new spectrum. High capacity is still main need for technology evolution. It should be able to provide data rates exceeding 10 Gb/s. Data rates of several 100Mb/s are easily achievable in indoor and dense outdoor environments.

III. Vision Of 3gpp

In march 2015, 3GPP decided to give expected timeline for the arrival of 5G in the world of telecommunication, i.e., the time by which 5G would be available without any constraints of structure , standardization, cost, setup and many more. A tentative 3GPP official timeline as given by 3GPP is shown in fig.4 .

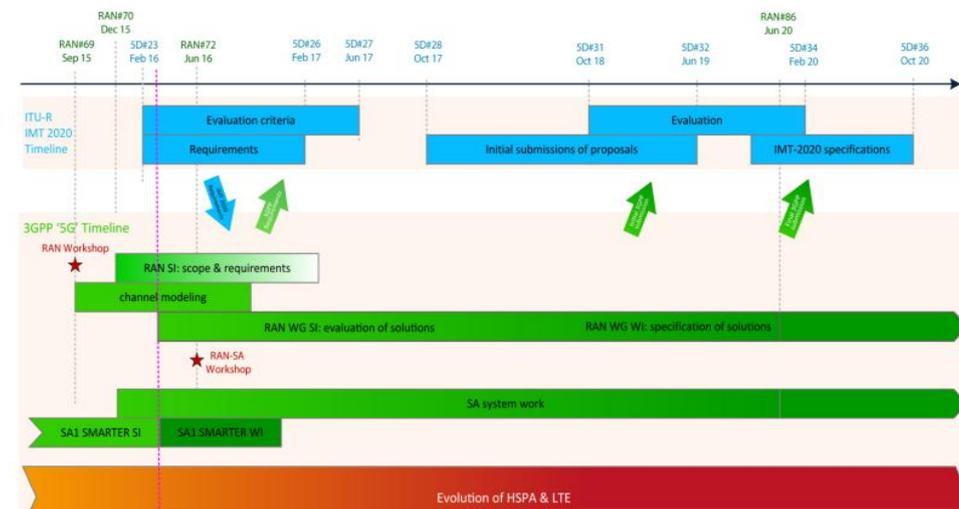


Fig.4.Tentaive 3GPP timeline of 5G [4]

IMT-2020

IMT-2020 is a process which looks at the gaps in the standardization of 5G .It was put forward by ITU-R. Focus Group, established in MAY 2015, as said by its chairman ,has a vision focus on software Isolation , i.e., the ability to automate how things operate .they are also laying stress on the ability to look at the open source community and Information Centric Networking (ICN) can be one of the considerable points of Focus Group. Apart from these, according to 3GPP, there are 2 submission deadlines related to IMT-2020 which are as follows: [4]

- Initial technology submission by ITU-R WP5D meeting #32, June 2019.
- Detailed specification submission by ITU-R WP5D meeting #36, October 2020.

RAN

There are several working groups which are working on the radio access technology for 5G. Discussion on Radio access for 5G would start with TSG RAN study to understand[4]:

- Requirements of IMT-2020, i.e, the requirements to fill the gaps which are creating problems in making 5G a success.
- Scope and requirements of new radio access for 5G.

IV. Spectrum For 5g

To deal with the increased traffic demands and to enable transmission bandwidths supporting high data rates, 5G will extend its frequency range focussing more on below 6GHz[5]. Although, it is still unclear what spectrum in higher frequency will be made available for mobile communication and for now up to 100GHz is considered. The lower part of frequency range, below 30GHz is preferred from point of propagation properties. Systems for low and high frequency bands are designed differently, however, in new frequency bands especially mmWave systems[6]; there is no need for fine tuning to achieve extreme spectral efficiency.



Fig.5.Spectrum band for 5G

Thus, relevant spectrum ranges from below 1GHz up to order of 100GHz as represented in fig.5 .

V. Machine Type Communication

Applications of 5G technology will not be constraint to human information interaction alone. New applications that drive requirements and capabilities of 5G are about end-to-end communication of connected devices which will use World Wide Wireless Web (www). These machines will be using Internet Protocol version 6(IPv6) as billions of devices are connected. To distinguish them from human centric wireless communication, it is labelled or called as machine type communication (MTC)[7].

Depending upon their characteristics and requirements, these MTC applications are subdivided into broadly two categories, critical MTC and massive MTC. (fig.5.) [8]

A. Massive MTC: It corresponds to application of large number of devices including sensors, actuators and similar devices, and, use case that fall into this category include monitoring and automation of buildings and infrastructure, smart agriculture, logistics and fleet management.[9] These devices lead to following requirements for 5G-

1. Devices need to be of low cost.
2. Battery life should long enough.
3. These devices share small volume of data and low latency which is not a critical requirement.

B. Critical MTC: It includes applications like control infrastructure and wireless connectivity for industrial processes. These applications need extremely high reliability and availability of wireless connectivity. The end-to-end (E2E) latency communications are low- at millisecond level.

Many different use cases exist with varying requirements of connectivity between two ends of MTC, majorly; it includes remote machinery and Intelligent Transportation Systems (ITSs). [9]

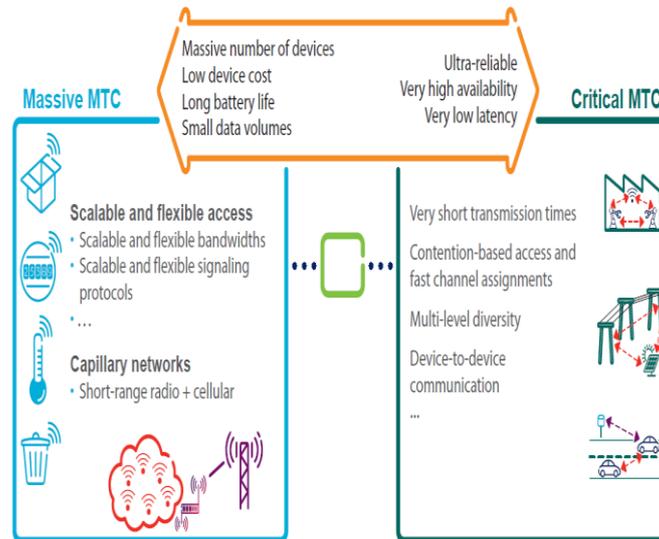


Fig.6. Massive MTC and critical MTC[8]

5G will drive the future evolution of the internet itself. What we mean when we refer to the “internet” is likely to change:

- Implementing the next generation of ubiquitous ultra-broadband network infrastructure will require a rethinking, restructuring and redesigning of approaches to mobile network construction and expansion.
- Integration of mass-scale cloud architectures will infuse mobile networks with capabilities for flexibly delivering services at unprecedented speeds while meeting forecasts for tremendous growth in mobile data traffic, diversification of mobile app innovation, IoT connectivity, and security.

VI. Use Cases

Lot of new services are envisioned for 5G which plays a crucial driver for new technology. We have presented this in the form of some of points as well as by fig.7 .

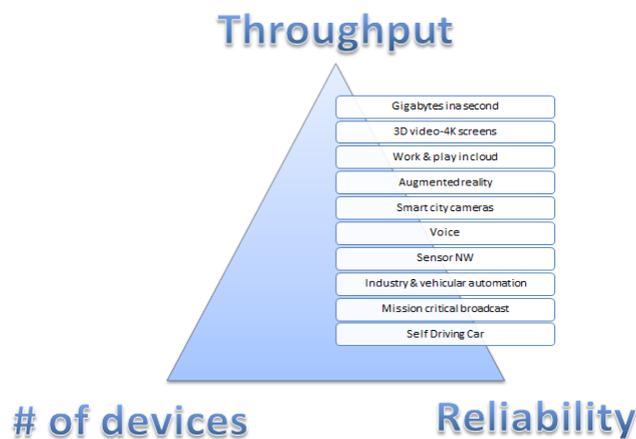


Fig.7. Diversity of use cases, services and requirements

- Mobile broadband: Broadband technologies like LTE will continue to evolve and going to play key role in radio access solutions beyond 2020. It goes far beyond mobile internet access and covers media and entertainment services in cloud services and applications.
- Automotive:[3] This sector has huge growth of mobile communication of vehicles. Fascinating use cases in this sector are augmented reality dashboards. Wireless modules will enable communication between vehicles, sharing and exchange of all required information like road maps, signals information and many more making “Smart Car”.
- Smart Society: cities and homes will be embedded with dense wireless sensor network with Artificial Intelligence (AI) capabilities having temperature sensors, window and heating controllers, burglar alarms and many more.

- D. Health: communication systems enable telemedicine and telesurgery like services. These services will provide instant treatment to patient, eliminating distance barriers between health clinics and patients.
- E. Industrial:[3] 5G wireless communication systems will provide many industrial applications. Wires add cost to installation and maintenance, but tempting wireless links provide boost and many new opportunities to industries. However, this wireless connection suffers through same delays, reliability and capacity issues. So, low delays and low error probabilities are new challenges and requirements for 5G systems.

VI. Expected Innovation From 5g Network (Voip)

Voice over Internet Protocol (VoIP): Voice over internet protocols basically means providing phone service over internet [11]. One having internet can make use of this technology. As it is expected that till the arrival of 5G technology a large part of world’s population would have high speed internet excess ,this 5G technology would serve in such a user friendly way with reduced calling cost as compared to earlier. There are, at present, various VoIP service providers but this field still needs some more time to show its real potential. How the VOIP works?[10]

Broadly the working of VoIP is shown in fig.8 while communication through VoIP can be in 3 possible ways which follows:



Fig.8.VoIP working [11]

(i) Using Analogue Terminal Adapter (ATA)



(ii)Using an IP phone



(iii) VOIP Connecting directly

It basically means connecting two IP phones directly with each other .However we require a NAT routers, otherwise there may be a problem in connecting VOIP directly.



VII. Advantages Of Using 5g

5G, once available, would make the life of people much easier .it would be much more user friendly, would have more exciting features, and many more things that would overwrite 5G on all other G’s. Some of these features 5G is expected to have are as shown in fig.9 as well and follows:

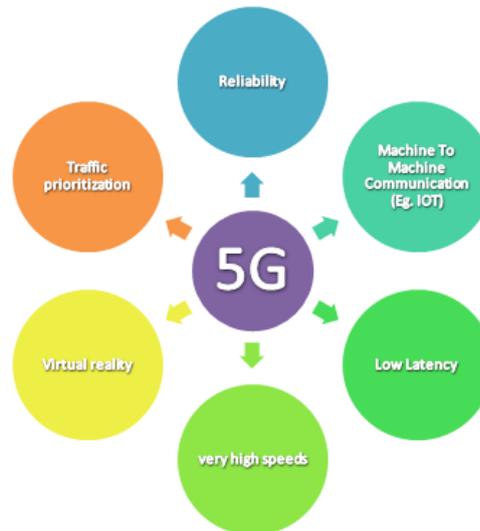


Fig.9.Some of the 5G Advantages and Application

- Low Latency: 5G is expected to have about 10 times more speed than the present scenario. This would drive machine to machine communication to a great success because a signal sent from one device to can be received by other device with very less delay which ultimately increases the precision.
- Virtual reality: Now as expected, 5G would make the world understand the actual meaning of virtual reality. Virtual reality basically means having various technologies or resources configured without any manual configuration.
- High reliability: It is strongly expected that 5G would have high degree of reliability and precision. Hence such type of communication can be used in critical situations ,like aircraft communication where due to less degree of reliability a great loss of life and money can occur.
- Traffic prioritisation: Traffic prioritization basically means providing brains to different vehicles moving on roads in auto steering mode , i.e., to provide the vehicles the authority to take decisions of changing the direction of the vehicle on the basis of signal received from nearby vehicles. This is made successful by 5G in a way that 5G has a very Low latency which ensure the precision of information and also precision in the time which makes it possible for a vehicle in auto steering mode to take correct decision on correct time.
- Helping hand to IOT: In present scenario internet of things (IOT) is most developing field which basically focuses on connecting different hard wares via internet. The most important requirement of IOT is low latency and reliability of communication network through which it tries to connect different hard wares and 5G could act as a great help as it has low latency as well as reliable communication network.
- VoIP: It would make whole world local by providing voice calling over internet that costs less.
- Zero-second switching: max 10 millisecond switching time between different radio access technologies to ensure a consistently seamless delivery of services.
- Massive capacity and always-on: Current mobile network systems already support 5 billion users; this will expand to support several billions of applications and hundreds of billions of machines.
- Low Energy consumption: energy-per-bit usage should be reduced by a factor of 1,000 to improve upon connected device battery life.

VII. Conclusion

Telecommunication industry has given us a lot which makes it more and more unpredictable .Due to increase pace of development in telecommunication field the expectation from 5G is very high .It is yet not possible for anyone to predict complete features of 5G but the features we have covered are the main reason that are attracting various market players to have investment in 5G technology. We hope this paper provides you a stronger links between various generations of mobile communication and understanding the needs and expectations from this complete new generations of 5G .We finally conclude by commenting that no one knows what exactly would be the feature of 5G but one can confidently say that this new era of mobile communication would make the present telecommunication system more efficient whether we say about increased data rates or in terms of spectral efficiency.

References

- [1]. C. X. Wang F. Haider ; X. Gao ; X. H. You ; Y. Yang ; D. Yuan ; H. M. Aggoune ; H. Haas ; S. Fletcher ; E. Hepsaydir ,Cellular architecture and key technologies for 5G wireless communication networks, *IEEE Communications Magazine*,52(2),2014,122-130
- [2]. Suvarna Patil; Vipin Patil ;Pallavi Bhat , A Review on 5G Technology, *International Journal of Engineering and Innovative Technology* ,1(1),2012
- [3]. NOKIA networks,“5G use cases and requirements” white paper.
- [4]. http://www.3gpp.org/news-events/3gpp-news/1674-timeline_5g.
- [5]. NOKIA networks, “looking ahead to 5G”, white paper.
- [6]. Theodore S. Rappaport, Shu Sun, Rimma Mayzus, Hang Zhao, Yaniv Azar, Kevin Wang, George N. Wong, Jocelyn K. Schulz, Mathew Samimi, Felix Gutierrez, *Millimeter Wave Mobile Communications for 5G Cellular: It Will Work!*. *IEEE Access*. [Online],1(),2013, 335-349.
- [7]. P. Jain , P. Hedman and H. Zisimopoulos,Machine type communications in 3GPP systems ,*IEEE Communications Magazine*. [Online], 50(11),2012,28-35.
- [8]. Ericsson,“5G Radio Access”, white paper, February 2015.
- [9]. Ericsson,“5G systems”, white paper.
- [10]. G.F.Mao , A. Talevski andE. Chang, *Voice over Internet Protocol on Mobile Devices*, *Computer and Information Science*, 2007. ICIS 2007. 6th IEEE/ACIS International Conference on, Melbourne, Qld., 2007 , 163–169.
- [11]. K. F. Kocan , *Moving to next-generation communication networks*, *Bell Labs Technical Journal [ONLINE]* .10(1), 2005, 1-3.