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Issues and Challenges in 5G Mobile Network

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I. INTRODUCTION

The history of Mobile communication technology starts 40 years ago and a lot has changed since then. The size of cell phones reduced ,text messages almost gone , downloading speeds have become faster and surfing the internet with phone is so common that people spend hours of time on it and an app for every purpose like entertainment, games, movies, education ,health and many more. The mobile communication network is known by its generations 1G, 2G, 3G, 4G and 5G.With the evolution of network, 5G powered technology have the capability to transform every sector and boost the economic growth in India and create new opportunities for both businesses and consumers. 5G will revolutionize the use of digital technologies in health care, smart factories, traffic systems, Robotics surgeries and autonomous vehicle system. The use cases are streaming high quality videos, more accurate location tracking with low latency in real time environment. The bands available in 5G are low- band, mid-band and high-band whereas mid-band is most preferred band and high-band is offering the fastest speeds among across short distances. This paper presents features, challenges in implementing and futuristic economical growth of 5G.

II. HISTORY OF MOBILE GENERATION

Mobile wireless communication system has gone through several elaboration stages after
the preface ofthe first generation mobile network in early 1980s.Let's take a look on the elaboration stages of wireless technologies for mobile communication.

1) *1G (First Generation):* This generation introduced the use of voice only calls with analog transmission of data. The most popular 1G system was Advanced Mobile Phone System (AMPS), Nordic Mobile Phone System (NMTS), Total Access Communication System (TACS), and European Total Access Communication System (ETACS). The frequency ranges between 800 MHz to 900MHz and FDMA (Frequency Division Multiple Access) techniques was used as access method in 1G.The voice quality was poor and with low battery life. Security did not exist as there was no encryption and download speed was slow up to 2.4Kbps.
2) *2G (Second Generation):* This generation introduced the use of digital voice with wireless transmission over GSM (Global System for Mobile communication).The data rate supports up to 64Kbps with enhanced security and roaming facility. The SMS facility and downloading with moderate mobile services. General Packet Radio Service (GPRS) or 2.5G was successfully implemented with maximum data rate up to 171kbps. Code Division Multiple Access (CDMA) system developed with maximum of 384 kbps data rate also introduced and implemented in the mid 1990s. Enhanced Data GSM Evolution (EDGE) or 2.75G also developed to improve data rate for GSM networks with maximum data rate of 473.6kbps. [1]
3) *3G (Third Generation):* This generation introduced the use of Universal Mobile Terrestrial / Telecommunication Systems (UMTS). UMTS has the maximum data rate of 384kbps and it support video calling for the first time on mobile devices. [2] Video streaming, video conferences, and live video chat with data transferring speed maximum up to 2Mbps were become so common. Even though features were also available in 2G but demand for faster data and Network usage increased in era of 3G due to its high speed wireless internet .The Features introduced in 3G were support of mobile apps, Multimedia message support(MMS),Television streaming,3D Games and Location tracking and maps(GPS). High Speed Downlink Packet access (HSDPA) and High Speed Uplink Packet Access(HSUPA), were developed to increase data rate and then later on Long Term Evolution (LTE) -3.9G developed .But there was requirement of higher bandwidth to accommodate higher data rate and infrastructure was costly .There was need to be compatible with 2G system .
4) *4G (Fourth Generation):* This generation introduced the use of Wireless transmission technologies like WiMax to enhance data rate and network performance and handling more advanced multimedia services.[3] The key features of 4G are reduced latency with data transfer rate maximum up to 1Gbps. It also supports Voice over LTE network VoLTE which uses IP packets for voice. The main problem with 4G was its expensive hardware and infrastructure and frequency bands were too expensive [5].

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5) *5G (Fifth Generation):* This generation introduced the use of low latency with higher bandwidth to deliver ultra fast internet and multimedia experience. Existing LTE advanced networks will transform into fast connectivity and supercharged 5G networks in future.5G is 30 times faster than 4G.[4]5G also supports larger frequency range between 30GHz and 300 GHz which is an essential requirement of IoT deployments and needed for smart cities and other industries in today's scenario.5G will work in both non standalone and standalone mode where non standalone supports both LTE spectrum and 5G-NR(New radio) spectrum and for standalone there is 5G – NR spectrum .

Comparison of 1G to 5G technology

Generation	Speed	Technology	Key Features
1G (1970 –1980s)	14.4 Kbps	AMPS,NMT, TACS	Voice only services
2G (1990 to 2000)	9.6/ 14.4 Kbps	TDMA,CDMA	Voice and Data services
2.5G to 2.75G (2001-2004)	171.2 Kbps 20-40 Kbps	GPRS	Voice, Data and web mobile internet, low speed streaming services and email services.
3G (2004-2005)	3.1 Mbps 500- 700 Kbps	CDMA2000 (1xRTT, EVDO) UMTS and EDGE	Voice, Data, Multimedia, support for smart phone applications, faster web browsing, video calling and TV streaming.
3.5G (2006-2010)	14.4 Mbps 1-3 Mbps	HSPA	All the services from 3G network with enhanced speed and more mobility.
4G (2010 onwards)	100-300 Mbps. 3-5 Mbps 100 Mbps (Wi-Fi)	WiMax, LTE and Wi-Fi	High speed, high quality voice over IP, HD multimedia streaming, 3D gamming, HD video conferencing and worldwide roaming.
5G (Expecting at the end of 2019)	1 to 10 Gbps	LTE advanced schemes, OMA and NOMA	Super fast mobile internet, low latency network for mission critical applications, Internet of Things, security and surveillance, HD multimedia streaming, autonomous driving, smart healthcare applications.

III. SUPPORTED 5G BANDS IN INDIA

The official launched of 5G has been done by PM Modi and Airtel has already rolled out its 5G services in 8 cities of India .The major participants in this play are Reliance *Jio*, Airtel, Vi(Vodafone-Idea).The mainly three bands are available :Low Band, Mid-Band and High Band mmWave.

1) The low-band frequencies include 600 MHz, 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, and 2500 MHz .The bands supported in this are n71, n28, n5, n8, n3, n1, n40 and n41.It has greater coverage but lower speeds[6].
2) Mid-band frequency is 3300 MHz and the band available is n78.It has balance of both coverage and speed. It covers large area across cities and many college campuses, parks and smart cities rely on the mid band to provide continuous service to IoT devices, cameras, and end users.
3) High-band frequency is up to 26 GHz, known as mmWave and the band available is n258. It offers higher speed but lesser coverage area. This band is ideal for ultra-low latency and high data rate to transmit large amount of data in real time [7].

IV. FEATURES OF 5G

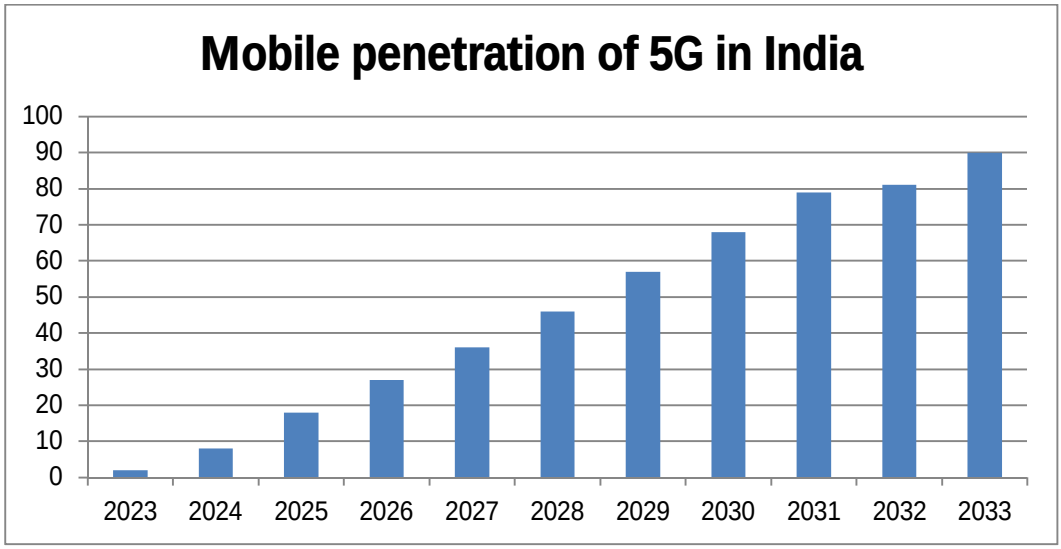
1) Enhanced Mobile Broadband (eMBB)-high speed data transfer and instant download in seconds with new experiences in Virtual Reality (VR) and Augmented Reality (AR).
2) Ultra-Reliable Low-Latency Communications (URLLC)-delays will be much less approximately to 1/10 of the 4G networks.
3) Massive Internet of Things (IoT) (mMTC) - Machine Type Communication (MTC), meaning millions of devices will be able to communicate with each other with high-band spectrum up to 20 Gbps and 5G will connect networks of embedded sensors in smart devices with low latency [8].
4) Millimeter-band radios (mmWave) - band of radio spectrum between 30 GHz and 300 GHz that can be used for high-speed broadband access.
5) Massive Multiple-Input Multiple-Output (MIMO) - wireless technology that uses multiple transmitters and receivers to transfer more data at the same time.

6) Network Deployment in Collaboration- Now the Technology companies, Cyber experts and the businesses will come together for networks deployment instead of earlier deployment where only telecommunications were used to discuss and deploy these networks.

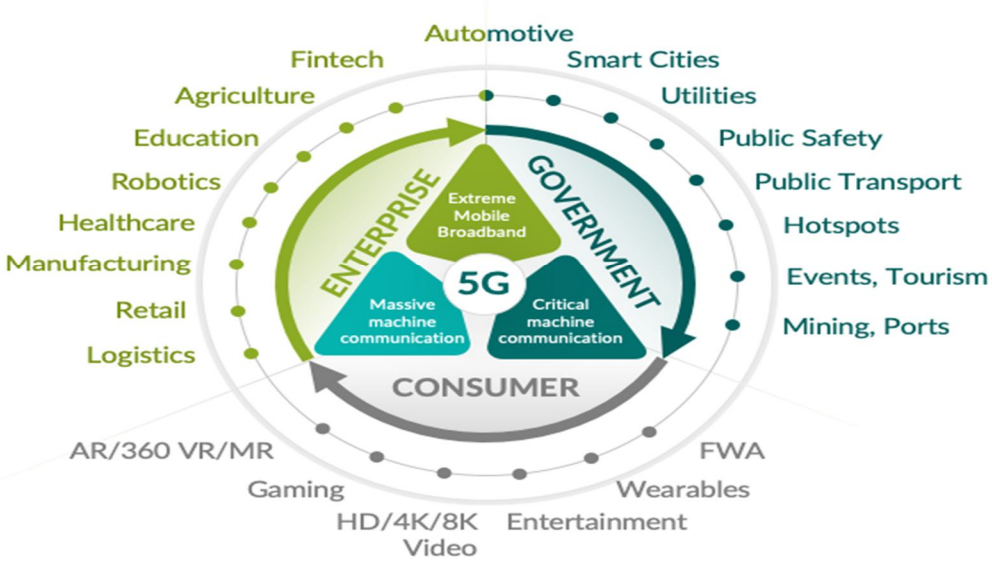
V. ECONOMIC IMPACT OF 5G IN INDIA BY 2023–2040

1) 5G will make overall contribution of $450 Billion in the economical growth of India over the period 2023-2040[11].
2) The penetration of 5G will increase from 2 percent to 4 percent in 2023 and will go up to 42 percent in 2028 and up to 90 percent in 2033[9].
3) In 2035, 5G will contribute to $13.2 trillion of global economic output and will create 22 million jobs.
4) From 2020 to 2035 the total contribution of 5G to real global GDP of the world will be equal to economy the size of India which is seventh largest economy in the world.

5G services will become main stream and are expected to range from the delivery of Virtual reality content to remote monitoring which is enabled by real-time communications (RTC) capabilities by 2030.



5G has capability to create several jobs in transport, retailing, Information & communication Technology, manufacturing and many other industries. 5G will unlock many new features with the use of artificial intelligence, IoT , cloud based services and real time propagation of information[10].



VI. SECURITY SUSCEPTIBILITY IN 5G

1) *Beamforming:* Science of electromagnetic to focus a wireless signal towards a specific receiving device without any interference and which allows faster transmission and fewer errors.5G networks is rolling out for smartphones and beamforming is key core technology which requires high level processing and efforts during planning stage[12] .
2) *Cost of Evolution:* There is need to double the fiber connectivity across the India because at present fibre connectivity is only 30% of India's telecom towers which needs to be upgraded to at least 80 % and cost of spectrum is almost 7 times as high compared to UK so accounting of pricing is need to done to get appropriate revenue from auction [13].
3) *Infrastructure:* There is difference between each band of 5G .While the lower band promises greater coverage for commercial needs but not for industrial purposes. The mid band has greater speed but less coverage and penetration and high band offers extraordinary speed nut limited in coverage so balance is required to maintain all these bands which require considerable infrastructure.
4) *Hardware Challenge:* Spectrum plays important role in 5g services so to upgrade mobile phones to 5G there will be need to change entire motherboard in case of old phones so to manufacture 5G enabled phones there will be requirement of efficient power amplifiers, Systems-on – chip (SOC) technology and other hardware and 5G depends on some foreign hardware which is banned by India in 'Make in India 'Project which is hurdle in implementing 5G.
5) *Health and Environmental Issues:* 5G signals are transmitted through small cell stations located at short distances which increase the impact of electromagnetic radiation which is extremely harmful. [14]The scrapping of old phones due to deployment on 5G enabled phones will cause lot of e-waste.
6) *Network Attacks:* While deploying to dense populated areas, 5G will configured to 5G NR non standalone (NSA) which uses both 5G NR (New Radio) standards and continue to existing 4G standards so current 4G bands will utilize the bands of 5G and 4G band is vulnerable to DoS (Denial of service) attack and many other threats like APN flooding , mobile to mobile attack so with 5G there is need to greater focus on privacy in the new era of security threats .

VII. CONCLUSION

This paper gives brief of individual cellular generation of mobile wireless technology. This revolution had started from 1G and emerging up to 5G. These technology has Personal Data Access to be whole office is in your finger tips. 5G will prove to be the reason for India considered to be developed. From this paper we can say that the number of mobile generation technologies which are grown very rapidly with the time span of over 50 years. The challenges in each technology lead to the generation of newer one. And now we are concentrating on the research towards the deployment of 5G technology which is the one makes us feel everything connected as real-world with the very high data rate and capacity. There are as many challenges in the deployment that should be seriously addressed for the better connectivity and applications of the mobile user. There must be mutual agreement between different stakeholders for successful deployment of 5G on large scale.5G networks have cloud based storage so no boundary for operators to control the privacy and protect the data on cloud environment so user privacy is seriously challenged when data is stored in cloud of different countries so technology providers has to overcome challenges in terms of signal spectrum, transmission protocols, security and network compatibility

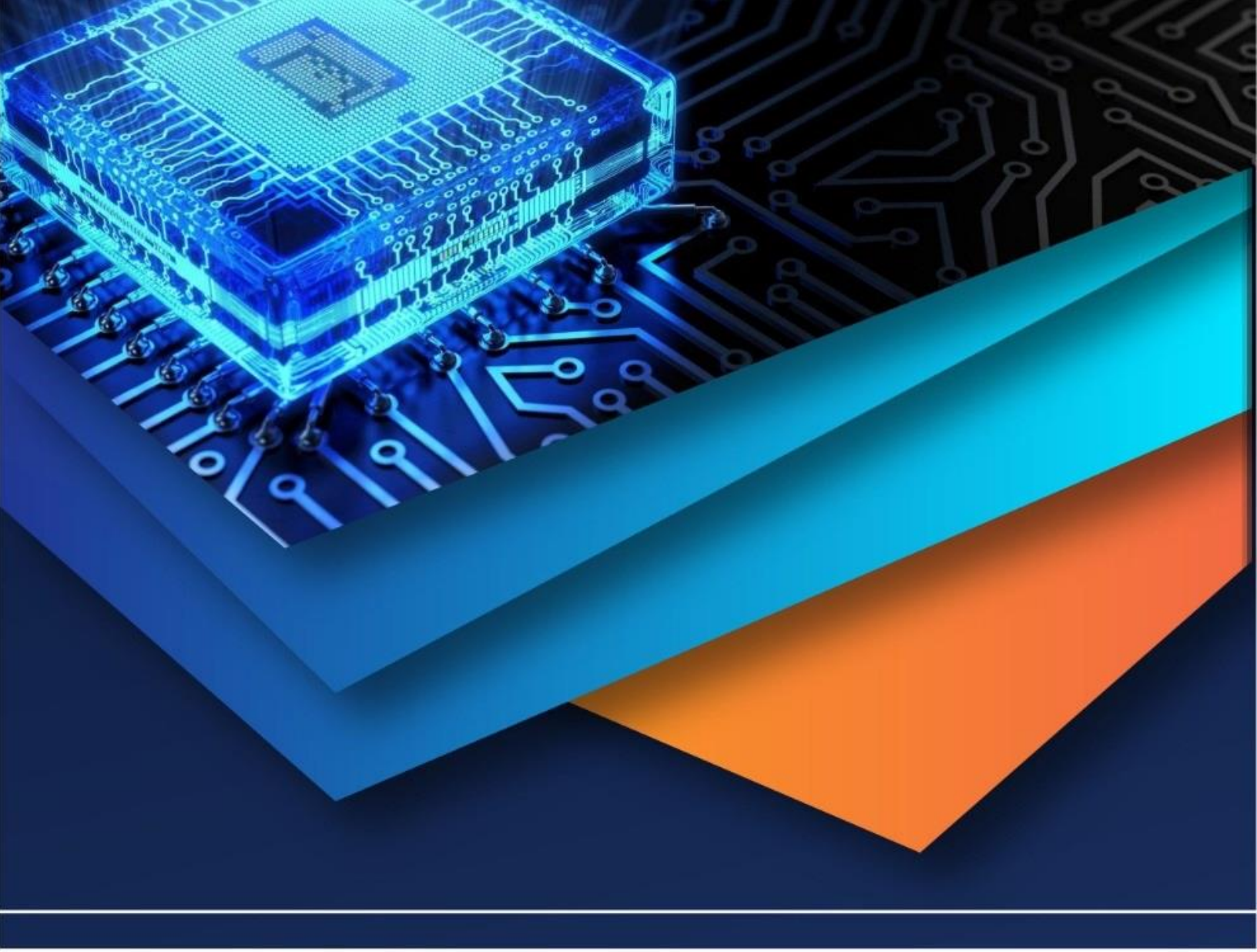
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