5G- A REVOLUTIONARY FUTURE OF NETWORKING

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ABSTRACT:

5G will change the way most high-bandwidth users access their Phones as well as computer systems. As 5G pushed over a VOIP (Voice Over Internet Protocol)-enabled device, people will experience a level of call volume and data transmission never experienced before.5G technology is offering the services in Documentation, Product Engineering, supporting electronic transactions (e-transactions-Payments). Today the customer becomes more and more aware of the mobile phone technology, he or she will look for a decent package allot once, including all the advanced features a cellular phone must have. Hence the search for new technology is always the main reason of the leading cell phone giants to out innovate their competitors also. Lately apple has produced shivers all around the electronic world by launching its new handset. Characteristics that are getting embedded in such a small piece of electronics are vast.

5G design is based on user-centric mobile environment with many wireless as well as mobile handset technologies on the ground. In dissimilar wireless environment changes in all, either new or older wireless technologies, are not possible, so each solution towards the next generation mobile and wireless networks must be applied in the service layer although the RAT(radio access technology) belong to the transport layer regarding the NGN(Next Generation Networks) approach. As the proposed design the user terminal has possibility to change the Radio Access Technology (RAT) based on certain criteria.

The purpose of transparent change by the mobile terminal in the RAT (Radio Access technology) s, is a technology introduced known as so-called Policy-Router as node in the core network, that establishes IP tunnels to the mobile terminal via different available Rats to that terminal. Selection of RAT (Radio Access technology) is thus achieved by the mobile terminal technology by using the projected user agent for multi-criteria decision making based on the understanding from the performance measurements performed by the mobile terminal itself.

The present paper studies the benefits of 5G network in different fields. It studies the architecture of 5G network. The paper also talks about the introduction of 5G in India. In the end of paper an attempt is made to study the challenges in implementing 5G in India.

KEY WORDS: **Architecture. Challenges, Network, 5G**

I. INTRODUCTION:

5G- The Revolutionary Future of Network

5G is the marketing term for technologies that fulfill ITU IMT-2020 requirements and 3GPP Release 15. 5G will use additional spectrum in the existing LTE frequency range (600 MHz to 6 GHz) and new Millimeter wave bands (24-86 GHz), which can upkeep data rates of up to 20 gigabits per second (Gbit/s). Main features of 5G include high mobility, less latency and maximum throughput. 5G technology will use massive MIMO (Multiple Input Multiple Output) to meaningfully increase the network capacity.

5G network services divided into three categories

- Handsets or enhanced Mobile Broadband (eMBB)
- Massive Machine Type Communications (MMTC) or sensors.
- Ultra-Reliable Low-Latency Communications (URLLC), which includes industrial applications and autonomous vehicles.

At starting 5G deployments will focus on eMBB and fixed wireless, which makes use of many of the same capabilities as eMBB.

II. OBJECTIVES AND METHODOLOGY:

The objectives and the research methodology are as follows:

OBJECTIVES OF STUDY:

The present study has been geared to achieve the following objectives;

1. To study the benefits of 5G Network and 5G architecture
2. To study the introduction of 5G in India
3. To study the challenges in implementing 5G in India

RESEARCH METHODOLOGY:

Type of Research: Exploratory and Analytical Research

Data Collection Method: This study has been carried out with the help of secondary data only, all the data has been collected from the various sources such as websites & reports and compiled as said by the need of the study.

Sources of Data Collection: The study is based on the published data. For the purpose of present study, the data was extracted from the various newspapers, journals, articles and websites.

III. Why 5G

The criteria for networks to be certified as 5G are as follows, as per GSM Association:

- Higher uploading and downloading speed as compared to 4G(existing network), with proposed 5G network minimum downloading speed will be 1 Gigabytes per second (GBps), and projected normal speed of about 10GBps
- 1 millisecond latency
- 1000x bandwidth per unit area
- 10 to 100x number of connected devices
- Around 99.99 per cent availability
- Around 100 per cent coverage
- 90 per cent reduction in network energy usage
- Up to 10 years of battery life for low-power devices

IV. Benefits of 5G Network

- **Media and Entertainment**

  High-quality streaming video for mobile devices (4G has brought us this, but 5G will do the streaming much faster, and more people in more locations can do this at same time) mobile virtual and enlarged reality gaming and down the road, immersive integrated entertainment, gaming, and media, which environs you and you can share with others if you wish (yes, folks, we can vegetate in imaginary worlds bonded to our mobiles).

- **Automotive**

  The world of independent self-driving cars that shows up at your home and gently whisks you to your office is going to happen anytime soon in world, given the complexities of driving (watch out for that guy on the motorbike coming straight at you on the wrong side of the road) or the lack of proper street numbering.

- **Agriculture**

  Agriculture is fairly possibly the biggest impact area in India. Once there are sensors in place, it is quite possible to run farms with minimum water, fertilizer, and pesticide use. By organizing ground-

level observation with drones and satellite-level data, there will be an opportunity to manage farms, especially in these times of water shortage and uncertain weather. The Big Data that is thus taken may even be used in combinations with artificial intelligence and machine learning to improve the automation of farms, especially in boutique farming such as for cash crops like vanilla or cocoa.

- **Healthcare**

Home healthcare delivery and remote robotic surgery are likelihoods. There are large numbers of people who are outside the normal reach of experts by virtue of their inaccessibility. High data throughput will certainly help in tele-medicine. There is also an increasing number of senior citizens who are on their own, and monitoring them remotely will be useful. Robotics surgery may be a little down the road, but the low latency in 5G technology will make it a more real-time experience for the doctors.

- **Supply chain and Transport**

With better route planning in real-time and re-routing around blockages, efficiency in transport can be achieved for say, trucking and railways. Going one step further, IoT-based and block chain tracking of goods will decrease pilferage and adulteration. Smart parking spaces with built-in IoT devices will make it easier to manage the inventory of slots and easier for car owners to park as well as locate their cars after. Similarly, Smart tags can be used to continuously monitor freight at the package level.

- **Energy management and Home automation**

By creating networks of devices that can be controlled and monitored remotely, it is possible to improve efficiency. In addition, having the ability to provide a dynamic monitoring of energy use and consume it from the grid at the lowest cost (e.g., set your washing machine to run at 4am or turn off your fridge from 7pm to 10pm automatically while sustaining the temperature). As more households opting for solar energy and electric cars, the ability to manage grid input and output will be useful with 5G network.

V. 5G Architecture

The system model of 5G is entirely **IP** (Internet Protocol) based model designed for the wireless devices and mobile networks.
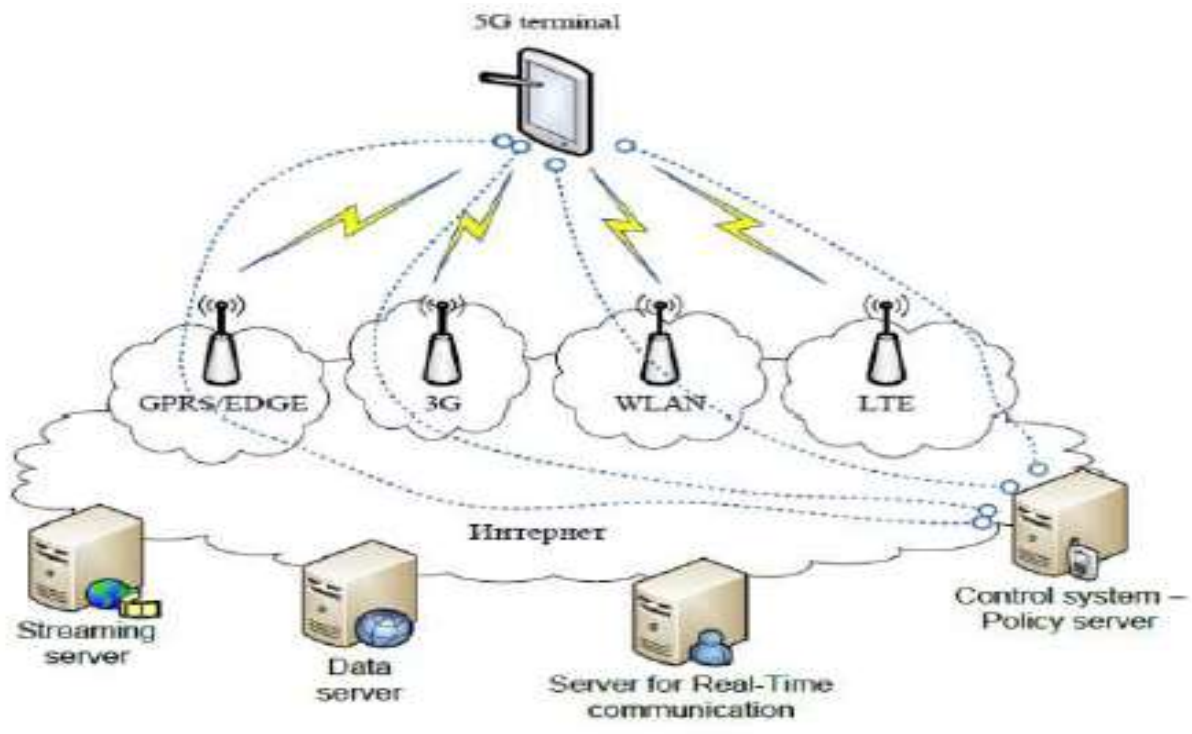
Figure 1: 5G Architecture

The system includes main user terminal and then a number of autonomous and independent radio access technologies. Each of the radio technology is considered as the IP (Internet Protocol) link for the outside internet world. The IP technology is designed completely to ensure satisfactory control data for suitable routing of IP packets related to a certain application connections i.e. sessions between client applications and servers somewhere on the Internet world.
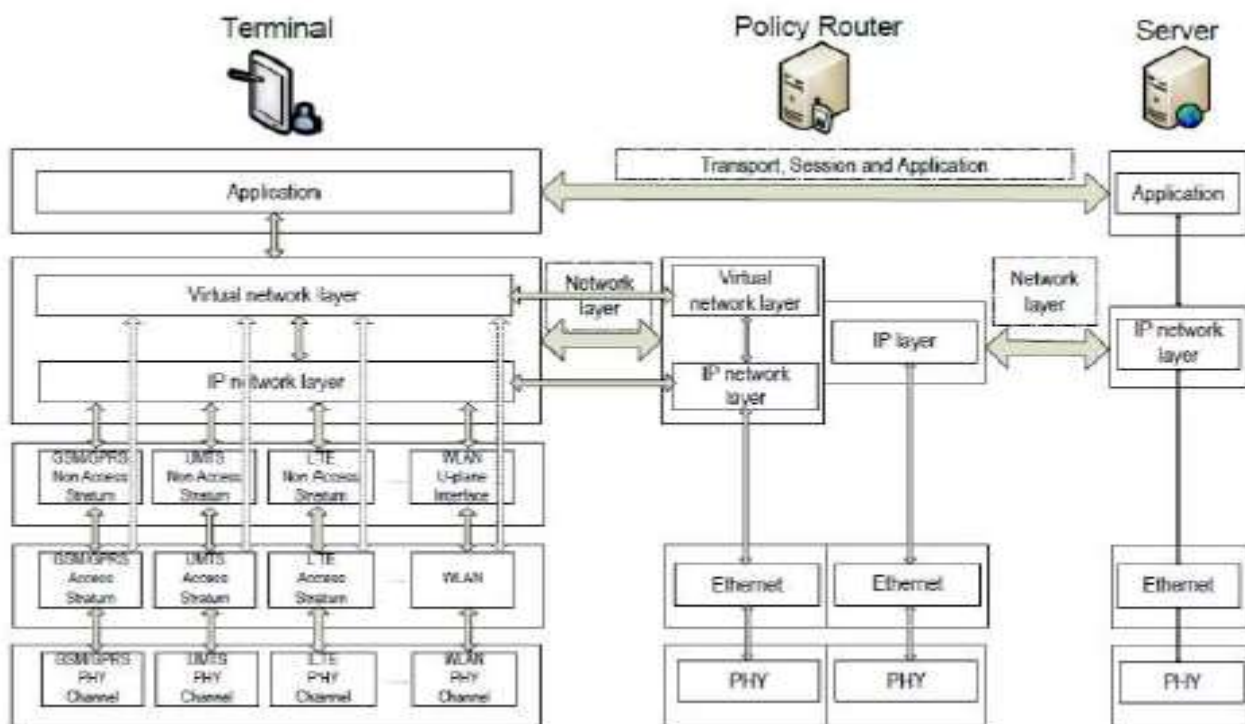

Figure 2: Network Architecture

VI. 5G VS EXISTING NETWORKS

Network	Deployment	Bandwidth	Technology	Service
3G	2004-05	2MBPS	Broadband with CDMA/IP/ technology	Integrated high quality audio, video and data
4G	2006-10	200MBPS	Unified IP and seamless combination of LAN/WAN/WLAN/PAN	Dynamic information access, variable devices
5G	By 2020	>1GBPS	4G+WWWW	Dynamic information access, variable devices with all capabilities.

VII. SIGNIFICANT USES OF 5G

- Cloud based systems will be able to stream software updates, music, navigation data and traffic conditions to driverless cars.
- Download time of high definition full length movies will be seconds not minutes.
- 5G speeds offer the potential for simultaneous language translation between people attending a teleconference.

Capabilities

According to IMT-2020 specifications, 5G network is expected to provide improved device and network level capabilities, tightly coupled with intended applications.

These below network parameters are key capabilities for 5G network

Capability	Description	5G Target	Usage Scenario
Peak data rate	Maximum achievable data rate	20 Gbit/s	eMBB
User experienced data rate	Achievable data rate across coverage area	100 Mbit/s	eMBB

Latency	Radio network contribution to packet travel time	1 ms	URLLC
Mobility	Maximum speed for handoff and QoS requirements	500 km/h	eMBB/URLLC
Connection density	Total number of devices per unit area	$10^6/km^2$	MMTC
Energy efficiency	Data sent/received per unit energy consumption (by device or network)	Equal to 4G	eMBB
Spectrum efficiency	Throughput per wireless bandwidth and per network cell	3-4x 4G	eMBB
Capacity of Area traffic	Full traffic across a coverage area	10 (Mbit/s)/m^2	eMBB

The goal of 5G is to provide user experience matching fixed networks via increased data rates, improved spectrum efficiency, reduced latency and better mobility support. This will impact enabling a vast network of machine-to-machine communications as well as traditional device communications without undue energy consumption, deployment costornetwork equipment cost.

Deployment

Development of 5G is being led by companies including Intel and Qualcomm for modem technology and Huawei, Ericsson, Nokia, ZTE and Samsung for infrastructure.

Launch of 5G technology is expected in 2020 worldwide, and Qatar operator Ooredoo in May 2018 launched the first commercial network. Number of operators has demonstrated 5G as well, including Korea Telecom for the 2018 Winter Olympics and in india by airtel in early 2018.

In the United States, the four major carriers have all announced deployment as:

1. AT&T's millimeter wave commercial deployments in 2018 Verizon's 5G fixed wireless launches in four U.S. cities and millimeter-wave deployments
2. Vodafone performed the first UK trials in April 2018 using mid-band spectrum
3. Sprint's launch in the 2.5 GHz band and T-Mobile's 600 MHz 5G launch in 30 cities.
4. China Telecom's initial 5G build out in 2018 will use mid-band spectrum as well.

Beyond mobile operator networks, 5G is also expected to be widely utilized for private networks with applications in industrial IoT, enterprise networking andcritical communications as well.

Country or Territory	Operator	Launch date	Bn78 3500 MHz	CA schemes	Notes
Qatar	Ooredoo	May 2018	(?)	(?)	World's first commercial 5G network.
Saudi Arabia	STC	May 2018	(?)	(?)	
Germany	Telekom	*May 2018*	(?)	(?)	*(pre-commercial) small-scale demo-network as of May 2018*
Russia	Rostelecom / Tattelecom	*May 2018*	(?)	(?)	*(pre-commercial) small-scale demo-network as of May 2018*

Spectrum

Supporting increased throughput needs of 5G network, large number of new spectrum have been allocated to 5G, particularly in mmWave bands. For example, in July 2016, the Federal Communications Commission (FCC) freed up vast amounts of bandwidth in underutilized high-band spectrum for 5G. Spectrum Frontiers Proposal (SFP) has doubled up the amount of millimeter wave (mmWave) unlicensed spectrum to 14 GHz and created four times more of amount of flexible, mobile-use spectrum the FCC had licensed to date. In March 2018, European Union lawmakers agreed to open up the 3.6 and 26 GHz bands by 2020.

Mobile Networks

In starting5G launches in the sub-6 GHz band will not diverge architecturally from existing LTE 4G infrastructure networks. Deployments are expected to follow a out dated macro cell model, while future millimeter wave deployments will multiply small cells as a result of higher capacity requirements and reduced broadcast range. List of top network equipment suppliers worldwide are namely as Nokia, Ericsson and Huawei.

5G Modems

Top modem manufacturers have significantly investing in the 5G modem market. Intel announced its XMM8000 series of 5G modems, including the XMM8060 modem, both of which have expected productization dates in 2019. Qualcomm announced its X50 5G Modem in October 2016, and in November 2017, In February 2018, Huawei announced the Belong 5G01 terminal device with an expected launch date for 5G-enabled mobile phones of 2018 and Mediatek announced its own 5G solutions targeted for 2020 production. Samsung is also working on the Exynos 5G modem, but has not announced the launch date.

5G Networks

Renowned operators have announced 5G trials and network launches as.

United States

US operators launch plans fall into two distinct categories:

- Fixed wireless

Fixed wireless typically services residential broadband customers with speeds in excess of 1 Gbit/s using mmWave bands.

- Mobile.

Sub-6 GHz spectrum will be used in Mobile launch for newly-allocated or outdated LTE bands with similar performance of LTE network.

Operator	Fixed Wireless			Mobile		
	Launch Date	Bands	Launch Geographies	Launch Date	Bands	Launch Geographies
AT&T	TBD	28/39 GHz	Trials: Austin, Waco, South Bend, Kalamazoo	End 2018	TBD	Dallas, Waco, Atlanta (12 cities total)
Verizon	2H 2018	28 GHz	3-5 cities including Sacramento (2H18)	1H 2019	TBD	TBD
Sprint	N/A	N/A		1H	2.5 GHz	Atlanta, Chicago, Dallas, Houston,

				2019		Los Angeles, Washington, New York, Phoenix, Kansas City
T-Mobile	End 2018	28/39 GHz	Trials: Bellevue, WA	End 2018	600 MHz	Los Angeles, New York, Las Vegas, Dallas (30 cities total)
Dish Networks	N/A	N/A		2020	600 MHz	
Charter Communications	End 2018	28 GHz	Orlando, Reno, Clarksville TN, Columbus, Bakersfield and Grand Rapids			

VIII. 5G IN INDIA

5th generation wireless systems, or 5G is about to take over the telecom market in India. Since last few weeks, several new developments have been reported with respect to 5G deployments in India, both from private as well as Govt. sector.

Government's stand in this regard is especially encouraging, because now, they are determined to deploy 5G across the country by 2020.

Private sector is also not behind as it has already taken the initiative, as Airtel has launched India's first 5G capable network in Indian circle. For tech enthusiasts, this is indeed a good time to be active.

AIRTEL LAUNCHES INDIA'S 1ST 5G CAPABLE NETWORK

Bengaluru and Kolkata known as the Silicon Valley's of India have become the lucky Indian cities to get 5G network in India. Airtel has just deployed Massive Multiple-Input Multiple-Output (MIMO), which has been claimed to be India's first 5G capable networks in the region.

This all has been done under Airtel's Project Leap network transformation program, wherein the network capability, using the same spectrum has been expanded by three to seven times .Explaining the technicalities, Airtel said in a statement: "Massive MIMO creates 3D beams both on horizontal and vertical

planes towards users located within its coverage footprint, Which indirectly helps in refining coverage and reducing interference across users in different beams, there automatically improving signal quality (SINR) by 2 to 3dB. Serving multi users by re-using same set of resource blocks (MU-MIMO) with improved signal quality helps in improving spectrum efficiency, user experience and cell capacity"

Airtel has launched officially its "pre-5G technology", so airtel users will have the facility to access better coverage inside buildings and underground locations of buildings and other non-network reaching regions.

Indian Government Determined For Compete 5G Rollout throughout country

Meanwhile Govt. of India has said that want the entire nation to be equipped and powered with 5G network, by 2020.

A committee of Ministers from telecom of higher authorities, information and technology has been formed, which will oversee the deployment of 5G, in the next 3 years or as early as possible, throughout India.

Ministry of State for Communications said, "We missed the opportunity to participate when the standards were being set for 3G and 4G, but don't want to miss the 5G opportunity. When the whole world standardizing for 5G, India will also be the participant of this revolutionary process,"

As per the initial plan, rural locations would be covered under 1 Gbps speed and every urban location in the country would be provided with 10 Gbps broadband speed.

TRAI (Telecom Regulatory Authority of India) has already released consultation paper to seek feedback related with 3300-3400 Mhz and 3400-3600 Mhz bands which would be used for 5G network across the country in upcoming time.
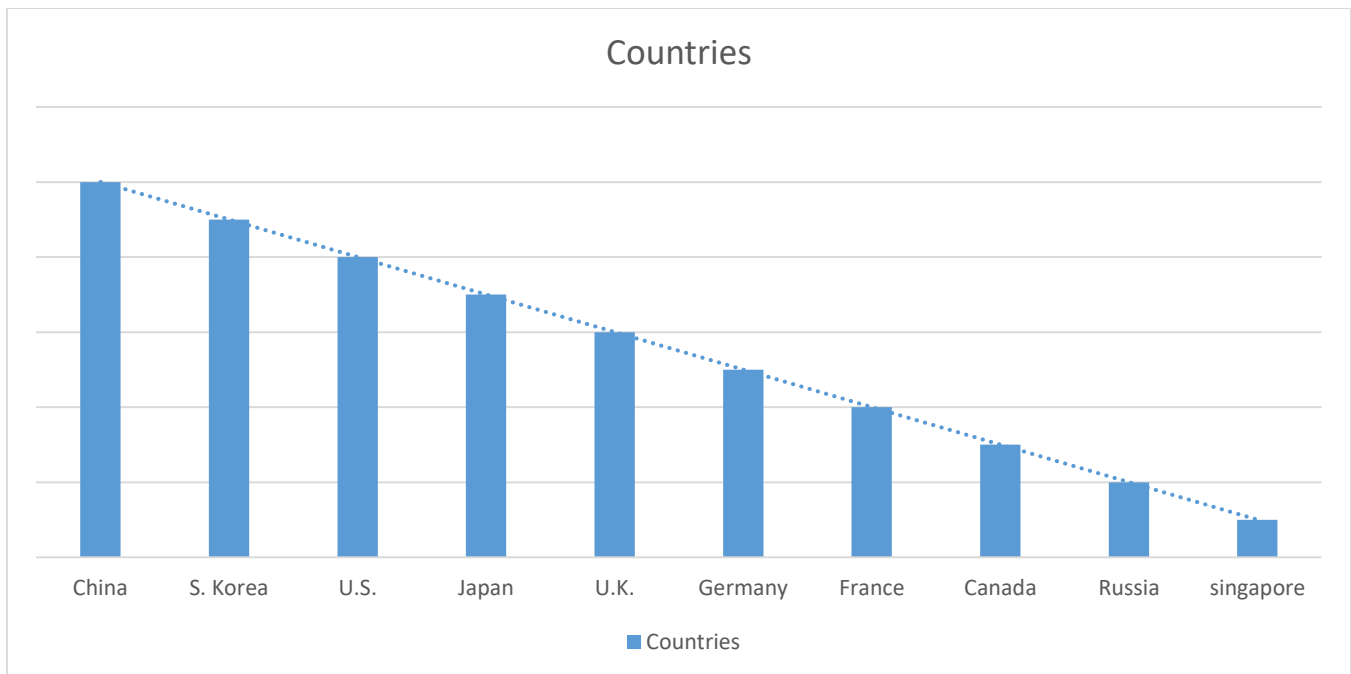
IX. 5G READINESS COUNTRIES COMPARISON

Figure 3:

In the chart above china stands 1st with its readiness to 5G network whereas Singapore is with 10th Rank.

5G Impact in USA

- $275 Billion Fresh Investment

- $500 Billion Economic Growth

- 3 Million New Jobs

5G Network Benefits

- Multiple tasks possible such as weather and location can be accessed same while talking to some other person on phone
- PC's can be controlled via smart phones
- Students can attend their classes even when sitting in any part of the world
- Revolution in medical treatment as a doctor can treat patient located in remote part of the world
- Crime rate can be reduce as government organization and investigating officers can monitor any part of the world
- Imagining galaxies, universe and planets will be possible
- Locating the missing person around the world will be easier
- Detection of natural disasters such as Tsunami, Earthquake is possible

5G Network Drawbacks

- Most of the old devices would not be proficient to 5G, hence, all of them need to be replaced with new one — expensive arrangement.

- Infrastructure needs high cost of development.

- Security and privacy issues are pretty needs need to be solved early.
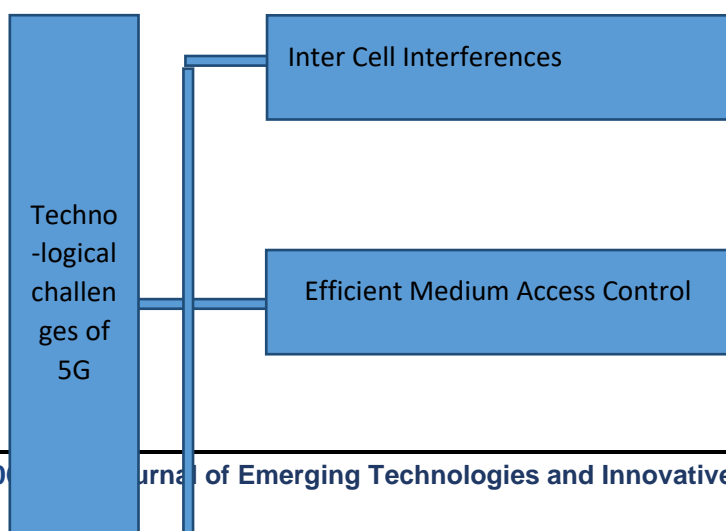
X. 5G NETWORK CHALLENGES

- **How far will 5G be practical?**

- **Will it be the technology for some of the developed countries or developing countries will also get benefit of this?**

There are many what and how arising with the development of 5G network some of the major challenges are discussed as follows

Technological Challenges

- **Inter-cell Interference** − this is one of the major technical issue that needs to be solved. There are differences in size of traditional macro cells and synchronized small cells that will lead to interfering.

- **Efficient Medium Access Control** − in situations, where dense deployment of access points and user terminals are required, there user throughput will be low, latency will be high, and hotspots will not be competent to cellular technology to provide high output. So it needs to be researched properly to optimize the technology.

- **Traffic Management** − In contrast to the traditional human to human traffic in cellular networks, a great number of Machine to Machine (M2M) devices in a cell may cause serious system challenges i.e., radio access network (RAN) challenge, which will cause excess and blocking.

Traffic Management

Figure 4: Technical Challenges

Common Challenges

- **Multiple Services** – dissimilar to other radio signal services, 5G would have a vast task to offer services to varied networks, technologies, and devices operating in different geographic areas. There so challenge is of regulation to provide universal, dynamic, user-centric, and data-rich wireless services to fulfill the high expectation of people around.

- **Legislation of Cyber law** − Cybercrime and other fraud may also increase with the high speed and global 5G technology. The legislation of the Cyber law is also an imperious matter, which largely is political and governmental (nationals as well as international issues) in nature.

- **Infrastructure** − Researchers are facing technological dares of standardisation and application of 5G services.

- **Privacy and Security** –5G network needs to ensure the protection for personal data, means it needs a higher perspective for both security as well as privacy. 5G network will have to define the doubts related to security threats including privacy, trust, cyber security that are growing across the world with this high speed network.

- **Communication, Navigation Sensing** − these are high speed facilities largely depend upon the availability of radio spectrum, through which signals are communicated towards. Although 5G technology has strong computational power to process the vast capacity of data coming from different and distinct sources, but it needs larger infrastructure support as well to perform computations faster than ever.
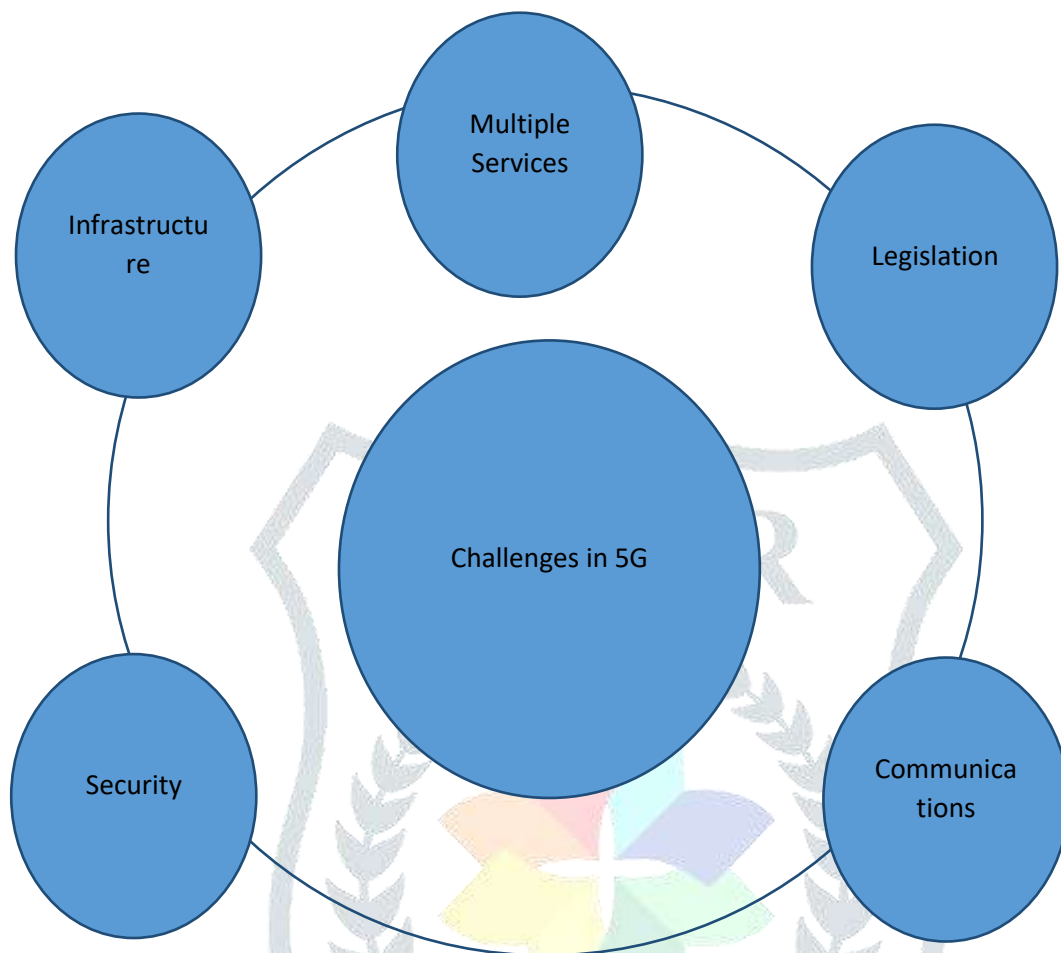
Figure 5: Common challenges in 5G

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