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A Study: 5G Next Generation Wireless Technology Test issues implications and research Challenges

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Abstract:

In recent Years our globe is experiencing lot of up gradation in telecommunication services. Everyone starting from private companies to government is contributing their level best to enhance wireless technology. Moreover the upcoming fifth generation cellular services aim at providing better quality of experience (QoE) with reduced energy consumption and end to end latency. This paper will concentrate on research issues related to new technology breed as well as the measurement and test challenges for 5G systems are also highlighted again it will also identify standards for 5G mobile communications.5th Generation mobile communicationis about to provide more enrichment to current telecommunications technologies, like changes in radio interaction and in spectrum. Increased Speed, Reliability & Accessibility of 5 Generations mobile wireless networks will be responsible for giving high performance to end users.

Keywords :5G, LTE building blocks, Evolution from 1G to 5G, Comparison of all Generations

I. Introduction:

1. **Data Overload.** Currently, Each Industry is well aware of extravagant value and commercialization of customer database and presently priority of data collection is increasing day by day. With mobile becoming part of basic in today's era consumer using it frequently by talking to smart speakers and depending upon Apps for routine activities which require internet access, Telecom providers need to give unlimited data to consumers thus giving access to privacy problems, adaptive ads & more customized healthcare.

2. **Digital centralization.** In recent past we have seen innovation of many technologies starting from smartphones to smart television and fleet of smart appliances making us to depend upon software application for routine activity. For instance we also have a app to check our daily diet. Smart speakers are a good step in the right direction, but 2018 may influence the rise of something even better.[1]

3. **Fifth generation** is based on 4G technologies. The 5th wireless mobile internet networks are real wireless world which shall be supported by LAS- CDMA(Large Area SynchronizedCode-DivisionMultipleAccess),OFDM(Orthogonalfrequency-division multiplexing), MCCDMA(Multi-Carrier Code Division Multiple Access),UWB(Ultra-wideband), Network-LMDS(Local Multipoint Distribution Service), and

IPv6. Fifth generation technologies offers tremendous data capabilities and unrestricted call volumes and infinite data broadcast together within latest mobile operating system. Fifth generation should make an important difference and add more services and benefits to the world over 4G. Fifth generation should be more intelligent technology that interconnects the entire world without limits. This generation is expected to be released around 2020.[10]

4. 5G preparation. Though tech timelines rarely play out the way we think, it's possible that we could have a 5G network in place—with 5G phones—by the end of this decade. 5G internet have the potential to be almost 10 times faster than 4G, making it even better than most home internet services. Accordingly, it has the potential to revolutionize how consumers use internet and how developers think about apps and streaming content. 2018, then, is going to be a year of massive preparation for engineers, developers, and consumers, as they gear up for a new generation of internet.

II. EVOLUTION OF WIRELESS TECHNOLOGIES

Mobile communication has become more popular in last few years due to fast revolution in mobile technology. This revolution is due to very high increase in telecoms customers. This revolution is from 1G- the first generation, 2G- the second generation, 3G- the third generation, and then the 4G- the forth generation,5G-the fifth second generation.

A. First Generation(1G) 1G arose in 1980s. It consisted Analog System and popularly termed as cell phones. It launches mobile technologies such as Mobile Telephone System (MTS), Advanced Mobile Telephone System (AMTS), Improved Mobile Telephone Service (IMTS), and Push to Talk (PTT). It is based on analog radio signal which works on frequency 150 MHz, voice call modulation is done using a technique called Frequency-Division Multiple Access (FDMA).It has low capacity, unreliable handoff, poor voice links, and no security at all since voice calls were played back in radio towers, making these calls susceptible to unwanted eavesdropping by third parties.

B. Second Generation(2G) 2G was launched in late 1980s. It used digital signals for voice transmission and has speed of 64 kbps. It provides facility of SMS(Short Message Service) and use the bandwidth of 30 to 200 KHz. Next to 2G, 2.5G system uses packet switched and circuit switched domain and provide data rate up to 144 kbps. E.g. GPRS, CDMA and EDGE

C. Third Generation(3G) It uses Wide Brand Wireless Network with which clarity is increased. The data are sent through the technology called Packet Switching. Voice calls are interpreted through Circuit Switching. Along with verbal communication it includes data services, access to television/video, new services like Global Roaming. It operates at a range of 2100MHz and has a bandwidth of 15-20MHz used for High-speed internet service, video chatting.3G uses Wide Band Voice Channel that is by this the world has been contracted to a little village because a person can contact with other person located in any part of the world and can even send messages too.

D. Fourth Generation(4G) 4G offers a downloading speed of 100Mbps.4G has same attributes as 3G with extra services like Multi-Media Newspapers, to watch T.V programs with more clarity and send Data much faster than previous generations. LTE (Long Term Evolution) is considered as 4G technology. 4G is being innovated to lodge the QoS and rate requirements set by future applications like wireless broadband access, Multimedia Messaging Service (MMS), video chat, mobile TV, HDTV content, Digital Video Broadcasting (DVB), minimal services like voice and data,and other services that utilize bandwidth. [10]

4G is identical with Long Term Evolution (LTE) technology, which is an evolution of the prevailing 3G wireless standard. Indeed, LTE is anprogressive form of 3G that marks an impudent shift from hybrid data and voice networks to a data-only IP network. There are two key technologies that enable LTE to achieve higher data throughput than predecessor 3G networks: MIMO and OFDM. Orthogonal frequency division multiplex (OFDM) is a broadcast technique that uses a huge number of closely-spaced carriers that are modulated with low data rates. It is a spectral efficiency scheme that enables high data rates and permits multiple users to share a common channel. Multiple-input multiple-output (MIMO) technique further improves data throughput and spectral efficiency by using multiple antennas at the transmitter and receiver. It uses complex digital signal processing to set up multiple data streams on the same channel.. The LTE standard uses both forms of duplex operations: Frequency division duplex (FDD) and time division duplex (TDD). Finally, a quick note about the LTE categories. There are different categories of LTE networks, and from a consumer perspective, they mainly differ in terms of theoretical speed under ideal conditions.

LTE-Advanced: The bridge between 4G and 5G LTE Advanced or LTE-A is the evolution of the original LTE technology toward even higher bandwidths. LTE-A promises nearly three times greater speed than the basic LTE network and comprises of the following five building blocks: 1. Carrier Aggregation 2. Increased MIMO 3. Coordinated Multipoint (CoMP) 4. Relay Station 5. Heterogeneous Network or HetNet 6. s Network or HetNet

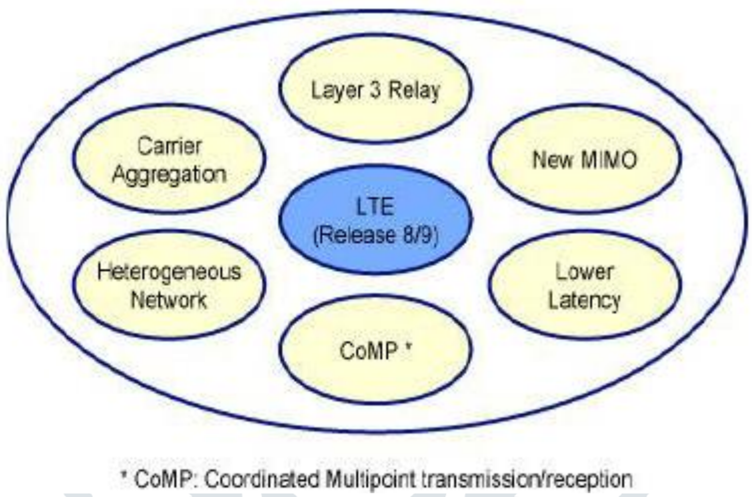

Figure-1. LTE building blocks

Carrier aggregation or channel aggregation is a transmission scheme that allows up to 20 channels from different spectrums to be combined into a single data stream. Next, LTE-A raises the MIMO bar to 8×8 antenna configurations to increase the number of radio streams using the beam steering technique. Third, CoMP or cooperative MIMO, allows mobile devices to send and receive radio signals from multiple cells to reduce interference from other cells and ensure optimum performance at the cell edges. Fourth, a relay in an LTE-A setting is a base station that uses multi-hop communications at the cell edges; it receives a weak signal and retransmits it with an enhanced quality. Fifth and the most crucial one is HetNet, a multilayered system of overlapping big and small cells to pump out cheap bandwidth. HetNet, a gradual evolution of the cellular architecture, is a vastly more complex network as small cells add hundreds or even thousands of entry points into the cellular system. The self-organizing network (SON) concept is one of the key enabling technologies being considered for LTE-A applications. Here, its worth noting that while LTE-A standard creates a bridge between 4G and 5G worlds, in many ways, the notion of HetNet is serving as glue between LTE-A and 5G worlds. Thats why many wireless industry observers call 5G wireless an enhanced form of LTE-A. That makes sense because the main concept behind 5G systems is to expand the idea of small cell network to a whole new level and create a super dense network that will put tiny cells in every room. The Next Generation Mobile Networks (NGMN) Alliance defines 5G as below: “5G is an end-to-end ecosystem to enable a fully mobile and connected society. It empowers value creation toward customers and partners, through existing and emerging use cases delivered with consistent experience and enabled by sustainable business models." Essentially, LTE-A is the foundation of the 5G radio access network (RAN) below 6 GHz while the frequencies from 6 GHz to 100 GHz will explore new technologies in parallel. Take MIMO, for instance, where 5G raises the bar to Massive MIMO technology, a large array of radiating elements that extends the antenna matrix to a new level—16×16 to 256×256 MIMO—and takes a leap of faith in wireless network speed and coverage.[11]

III. COMPARISION OF 1G TO 5G

CONTENT	1G	2G	3G	4G	5G
START	1970	1990	2004	NOW	SOON (2020)
DATA BW	2kbps	64kbps	2Mbps	1Gbps	>1Gbps
MULTIPLEX	FDMA	TDMA	CDMA	CDMA	CDMA
SWITCHING	CIRCUIT	CIRCUIT	PACKET	ALL PACKET	ALL PACKET
CORE NETWORK	PSTN	PSTN	PACKET N/W	INTERNET	INTERNET

4g And 5g Difference

a) First and foremost, while the LTE-based 4G networks are going through a rapid deployment, 5G networks mostly comprise of research papers and pilot projects.

b) Wireless networks till 4G mostly focused on the availability of raw bandwidth, while 5G is aiming on providing pervasive connectivity to lay grounds for fast and resilient access to the Internet users, whether they are on a top of a skyscraper or down under a subway station. Although LTE standard is incorporating a variant called machine type communications (MTC) for the IoT traffic, 5G technologies are being designed from grounds up to support MTC-like devices.

c) The 5G networks are not going to be a monolithic network entity and will be built around a combination of technologies: 2G, 3G, LTE, LTE-A, Wi-Fi, M2M, etc. In other words, 5G will be designed to support a variety of applications such as the IoT, connected wearables, augmented reality and immersive gaming. Unlike its 4G counterpart, 5G network will offer the ability to handle a plethora of connected devices and a myriad of traffic types. For example, 5G will provide ultra-high-speed links for HD video streaming as well as low-data-rate speeds for sensor networks.

d) The 5G networks will pioneer new architectures like cloud RAN and virtual RAN to facilitate a more centralized network establishment and make the best use of server farms through localized data centers at the network edges. e) Finally, 5G will spearhead the use of cognitive radio techniques to allow the infrastructure to automatically decide about the type of channel to be offered, differentiate between mobile and fixed objects, and adapt to conditions at a given time. In other words, 5G networks will be able to serve the industrial Internet and social network apps at the same time.

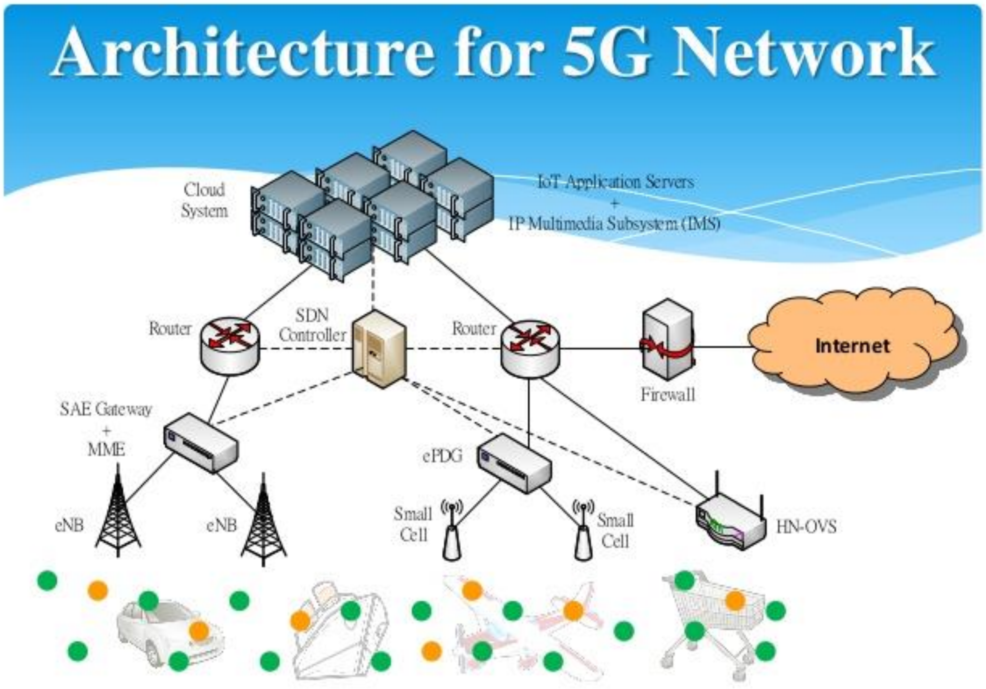

Figure-2. 5G Application architecture.

Table 1. Comparison of 4G and 5G Technologies

Specifications	**4G**	**5G**
Full form	Fourth Generation	Fifth Generation
Data Bandwidth	2Mbps to 1Gbps	1Gbps and higher as per need
Frequency Band	2 to 8 GHz	3 to 300 GHz
Standards	Al access convergence including OFDMA,MC-CDMA,network-LMPS	CDMA and BDMA
Technologies	Unified IP, seamless integration of broadband LAN/WAN/PAN and WLAN	Unified IP, seamless integration of broadband LAN/WAN/PAN/WLAN and advanced technologies based on OFDM modulation used in 5G
Service	Dynamic information access, wearable devices, HD streaming, global roaming	Dynamic information access, werable devices, HD streaming, any demand of users
Multiple Access	CDMA	CDMA,BDMA
Core network	All IP network	Flatter IP network, 5G network interfacing(5G-NI)
Handoff	Horizontal and vertical	Horizontal and vertical

Table 1. Comparison of 4G and 5G Technologies

These 5th generation of systems are driven by OFDM, MC-CDMA, LAS-CDMA, UWB, Network LMDS and IPV6. Table above compares 4G versus 5G technologies and mentions differences between them. [11]

IV. BENEFITS, FEATURES AND TRENDS OF 5G NETWORKS

Benefits of 5G Networks.

- **High Data Rate**:(By means of data rate how fast circuit can handle digital information)
- **Energy Saving**: (Decrease of energy consumption on user end)

- **Money Saving**: (Will save revenue by giving high networking facilities)
- **Less Congestion to a MBS**: (Less Congestion on Data traffic)
- **More Effective**: (Good in Quality of Service)
- **Low Latency**: (Fast Response in downloading)
- **Supportive High Speed Multimedia**: (Video Calling can be made more easily)
- **Clarity in Voice and Audio Calling**: (Enhanced Quality) User can get fast and Better solution through faster Network.
- **Large Broadcasting**: (Data can travel in GB/s)

5G expectations and features	Trends/proposals
Capacity and throughput improvement, high data rate (~1000x of throughput improvement over 4G, cell data rate ~10 Gb/s, signaling loads less than 1~100%)	Spectrum reuse and use of different band (e.g., mm- wave communication using 28~GHz and 38~GHz bands), multi-tier network, D2D communication, C- RAN, massive-MIMO
Reduced latency (2~5 milliseconds end-to-end latencies)	Full-duplex communication, C-RAN, D2D communication
Network densification (~1000x higher mobile data per unit area, 100~10000x higher number of connecting devices)	Heterogeneous and multi-tier network
Advanced services and applications (e.g., smart city, service-oriented communication)	C-RAN, network virtualization, M2M communication
Improved energy efficiency (~10x prolonged battery life)	Wireless charging, energy harvesting
Autonomous applications and network management, Internet of Things	M2M communication, self-organizing and cognitive network

[12]

V. Research Challenges and test issues for 5G Networks

Despite the fact that mentioned key-enabling technologies significantly mend the overall network performance and end-user QoE, there are several research challenges (from system/device design and testing to network management) to fulfill the requirements of 5G systems. In the following, we discuss the research challenges into two categories, namely, (i) measurement and test challenges for future 5G systems; and (ii) challenges for efficient management of the radio resources.

Measurement and Test Challenges for 5G Systems

In the following, we briefly present the key challenges related to measurement, testing, and validating the performance of 5G system components. Table II summarizes the issues that make the measurement and testing of 5G systems more challenging.

Measurement and modeling of the propagation channels: The fundamental challenge to measure and model the propagation channel is mainly due to use of higher frequencies and various bandwidths, together with much larger antenna arrays. The growth of wireless traffic requires additional spectrums (e.g., higher frequencies in the mm-wave) and the enabling technologies such as large-scale MIMO and densification of network nodes impose new requirements for channel measurement/modelling in the spatial domain. The key challenges/considerations for measuring and modelling the 5G propagation channels can be summarized as follows [14].

- **Efficient and realistic measurement:** Meanwhile the measurement data are vital for the necessary extensions/alterations of accessible propagation models, the measurement approach should capture diverse frequency range, spatial consistency, 3D (e.g., elevation) and spherical waves, as well as the new communications paradigms such as D2D/M2M and small cell communications. Besides, measurements should be carried out for mm- wave (e.g., 60 GHz and above) both in indoor/outdoor and considering possible realistic use-cases (such as crowded areas, vehicle-to-vehicle/roadside communications etc.). Spatial distributions and mobility: The existing channel models are drop-based, e.g., the scattering environment is randomly created for each link. However, since the density of links is expected to increase in 5G systems, it is important to model these links in a consistent manner which can also inherently support the heterogeneous mobility behavior of different network nodes.

- **Large-scale antenna arrays and mm-wave communication**: It is intended that 5G systems will use very large-scale antenna arrays for directive communication. Considering these directive antennas, current channel models require corresponding improvement in angular resolution as well as sub-path amplitude distribution. In addition, these large-scale antenna arrays need spherical wave modeling instead of the usually used plane wave approximation [14]. The use of mm-wave frequencies (particularly at 60 GHz) is projected to achieve spectrum and spatial multiplexing gain. However, the characteristics such as highly resolved angular properties and non-line-of-sight (NLOS) path-loss are not popular; and hence require further measurement studies.
- **Testing 5G systems:** The usage of wide channel bandwidths, high data rate requirements, fast response times, more complex antenna configurations, and support for multiple radio access technology (RAT) creates significant challenges to the development of next generation BSs and devices. Testing of 5G systems is not limited to the hardware only, but it will be also required to validate new communications algorithms and approaches.

From the perspective of an RF engineer, some of the key design and measurement challenges for 5G systems are as follows [15, Ch. 6]:

i. the requirement to handle multiple channel bandwidths (e.g., 1.4 to 20 MHz for LTE- operability in higher bands (e.g., 60 GHz for mm-wave);

ii. The use of different transmission modes in LTE-A (e.g., orthogonal frequency-division multiple access [OFDMA] for uplink, single-carrier frequency-division multiple access [SC-FDMA] for downlink) and also provisioning for both transmission modes (e.g., time/frequency-division duplexing [TDD/FDD]);

iii. support for multi-RAT (e.g., due to multi-standard radio transmission requirements) and simultaneous transmission/reception of control, energy and data;

iv. The spectral, power, and time variations (due to heterogeneous network traffic and node density), and need to support multi-antenna techniques (e.g., transmitter diversity, spatial multiplexing, beam forming).

The problems related to measurement and testing of the receiver radios for the 5G systems may include [15, Ch. 6]:

i. verifying the RF and baseband receiver (e.g., autonomic gain control, baseband demodulation and hybrid automatic repeat request [HARQ] functional testing);

ii. receiver performance under impaired conditions (e.g., phase noise and additive white Gaussian noise [AWGN] impairments);

iii. receiver performance testing (e.g., testing under channel propagation impairments);

iv. testing the MIMO-enabled systems (e.g., baseband coding assessment, receiver verification challenges such as isolation of signals, performance testing under static and faded channels). There are also challenges related to testing the 5G BSs and UEs as discussed below.

- **Challenges of testing the 5G BSs:** 5G systems will be able to reprocess some of the inherited infrastructure in the current core network. However, the 5G air-interface specifications will embrace a range of new attributes and concepts, and thus want a major development program. These attributes may include massive MIMO, low-latency HARQ procedures, high-order modulation schemes (e.g., 256 quadrature amplitude modulation [QAM]), the broad set of blends/configurations of RF bands and channel bandwidths to provide the spectrum flexibility, testing FD radios, and energy harvesting capabilities. As opposed to conventional systems, future BSs (including small cell BSs, relays etc.) will also need to handle radio resource control (including admission control, load balancing and radio mobility decisions) on top of the traditional Layer 1 and Layer 2 functionalities. In addition, the stress testing should be conducted for the BSs, clouds, and the core networks to validate the performance against large numbers of network nodes.

- **Challenges of testing the 5G UEs:** The testing concerns for 5G UEs are parallel to those for traditional systems using measurement matrices such as maximum output power, power control, and receiver sensitivity. However, the necessity for the use of OFDMA transmission scheme in the downlink and SC-FDMA in the uplink in LTE-A/LTE-B based 5G systems, as well as backing for simultaneous connections with facility for energy harvesting competences require new measurement concepts to support the essential tests. For proper RF measurements, the test instrument should integrate a signaling protocol that operates automatically with user definable parameters (such as channel number). The functional testing for the UEs should include testing signaling protocol, end-to-end throughput, and handover testing. One of the principal challenges for testing 5G UEs is to ensure that the state change response requirements are met. For example, in idle mode, the device will be in a low power consumption state to ensure good battery life, and only periodically check for paging messages. When the device is in connected mode (e.g., data transmission is to be scheduled), the device must wake up and rapidly synchronize its uplink/downlink (or even both in case of FD communication). To ensure energy efficiency, battery drain testing should be performed in all the phases (e.g., product development, design validation, and application design) of system development cycles [15, Ch. 6].

MEASUREMENT AND TEST ISSUES FOR 5G SYSTEMS

Particulars	Issues to consider
Channel measurement and modeling	Massive number of devices, heterogeneous traffic pattern and node density, support for spatial diversity (e.g., massive- MIMO), operability in higher bands, new use cases (e.g., D2D/M2M communication)
Testing RF modules, transmitters and receivers	Testing support for MIMO and beamforming capabilities, testing simultaneous transmission/reception and FD radios, testing under different propagation bands and under impairments, cost effectiveness (testing large number of units with low cost)
Testing BSs and UEs	Stress testing with large number of nodes, various traffic patterns etc., performance testing with standard (e.g., LTE-A) specifications, flexibility to operate with multi-standard, energy efficiency testing for UEs and low power nodes (e.g., small cell BSs, relays, RRHs etc.)

Challenges for open research issues

Enabling technologies and trends	Benefits and features	Applicability	Fundamental research challenges
Heterogeneous multi-tier networks	Increased throughput, spectrum utilization, energy efficiency, coverage expansion	Small cell networks, D2D/M2M communication, Internet-of-Things	Interference management, adaptive power control, dynamic mode selection and offloading to underlay network, device discovery, unified MAC design
Full-duplex communication	Spectrum efficiency, reduced latency, energy efficiency	Small cell networks, D2D communication, cognitive radio networks, multi- hop relaying	SI reduction, cross-layer resource management, power allocation, interference management,

			synchronization and time adjustment to establish FD transmission, dynamic mode selection, designing a MAC protocol
Energy harvesting networks	Energy efficiency, wire free and energy-aware (green) communication	Small cell networks,D2D/M2M communication	Muti-user scheduling, advanced channel acquisition, energy beamforming, harvest/transmit time adaptation, interference management, SWIPT-enabled resource allocation
Cloud RAN	Scalability, energy/power savings, increased throughput, reduced delay, adaptability to dynamic traffic, reduced CAPEX/OPEX, easier network management	Service oriented communication, heterogeneous networks	BBU management (e.g., cooperation, interconnection, clustering), energy-aware scheduling, fronthaul-aware resource allocation
Wireless network virtualization	Resource utilization, improved throughput, energy savings, reduced CAPEX/OPEX, enhanced QoE, easier migration/maintenance	Service oriented communication (everything as a service)	Isolation, resource allocation, fairness, revenue/price optimization, mobility management

Summary of emerging technologies for 5g cellular networks

VI. CONCLUSION:

This piece of work authors express the necessity, problem, issue and future challenges regarding 5G networks. In this regard extensive back ground of previous and present networks is given with contrast to the future 5G. The main focus of study is for improving QoS parameter so that those will be mainly focused after the deployment of 5Gmobile communications deployment in 2020. In future major Objective will be to control all the parameters of QoS during the migration from 4G to 5G through the well manageable technical grounds. Main focus for 5G development will be like algorithms for sorting of user traffic that will support changes in the market that includes demand of service of customers. Services that will use in future mobile network like Video services & services like M2M devices technology that exchange information and perform actions without the need of human's assistance.

References :

[1] https://www.forbes.com/sites/jaysondemers/2017/12/30/7-technology-trends-that-will-dominate-2018/#7dc96fdd57d7

[2]Bander Alzahrani; Mohammed Alreshoodi; VassiliosVassilaki; Abdullah Almuhaimeed; FawazAlarfaj” Toward secure packet delivery in future internet communications”2018 IEEE International Conference on Consumer Electronics (ICCE)Year: 2018Pages: 1 - 2

[3]J.Schonwalder; A.Pras; J. -P. Martin-FlatinOn the future of Internet management technologiesIEEE Communications MagazineYear: 2003, Volume: 41, Issue: 10Pages: 90 - 97

[4]PallaviNeog; Rabindranath BeraMulti-standard radio for 2G to 5G2017 2nd International Conference on Telecommunication and Networks (TEL-NET)Year: 2017Pages: 1 – 5IEEE Conferences

[5] Jaya Rao; Sophie VrzicPacket Duplication for URLLC in 5G: Architectural Enhancements andPerformance AnalysisIEEE NetworkYear: 2018, Volume: 32, Issue: 2Pages: 32 - 40
IEEE Journals & Magazines

[6] AmolDelmade; Colm Browning; Arman Farhang; Nicola Marchetti; Linda E. Doyle; R. David Koilpillai; Liam P. Barry; DeepaVenkitesh
Performance analysis of analog IF over fiber fronthaul link with 4G and 5GcoexistenceIEEE/OSA Journal of Optical Communications and NetworkingYear: 2018, Volume: 10, Issue: 3Pages: 174 – 182IEEE Journals & Magazines

[7] José A. del Peral-Rosado; José A. López-Salcedo; Gonzalo Seco-Granados
Impact of frequency-hopping NB-IoT positioning in 4G and future 5G networks2017 IEEE International Conference on Communications Workshops (ICC Workshops)Year: 2017Pages: 815 - 820

[8] Muhammad Sohail Hayat; Syed Imran Ali Kazmi; RazaHasan; Abdul Hadi Bhatti
An architecture of future wireless network for smart cities by improving 4G LTE wireless network2016 3rd MEC International Conference on Big Data and Smart City (ICBDSC)Year: 2016Pages: 1 - 5

[9]MuratAydemir; KorhanCengizEmerging infrastructure and technology challenges in 5G wireless networks2017 2nd International Multidisciplinary Conference on Computer and Energy Science (SpliTech)Year: 2017Pages: 1 - 5

[10] Ganesh R. Patil et al, International Journal of Computer Science and Mobile Computing, Vol.3 Issue.10, October- 2014, pg. 203-207 “5G WIRELESS TECHNOLOGY “ International Journal of Science, Engineering and Technology Research (IJSETR) Volume 1, Issue 1, July 2012

[11] A Comparative Study on 4G and 5G Technology for Wireless Applications B.G.Gopal1, P.G.Kuppusamy2,DOI: 10.9790/2834-10636772 ww.iosrjournals.org 68 | Page

[12] Ekram Hossain, Fellow, IEEE, and MonowarHasan, Student Member, IEEE 5G Cellular: Key Enabling Technologies and Research Challenges