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# Role of 4G and 5G Network in Supporting the Connectivity Requirements of Internet of Things

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***Abstract*— In this paper, we will provide an overview of 4G and 5G with respect to Internet of Things perspective. IoT is the talk of the 21st century and mobile broadband is the driving force behind it. Lot of research is going on around the globe through academic, industry, government and R&D organizations in realizing the IoT. At present, IoT is in semi conceptual stage and the practical deployment is facilitated only with the emerging 5G technology. In this paper, we have presented some of the latest developments, ideas and prototypes.**

***Keywords* – Internet of Things (IoT), Long Term Evolution (LTE), Machine to Machine (M2M), 4G, 5G**

## I. INTRODUCTION

Mobile Wireless Communication networks have experienced a remarkable evolution in the last few decades. Mobile wireless communications applications have a clear impact on improving the humanity wellbeing. From mobile phones to wireless internet for office and home devices, most of all the applications are converted from wired to wireless communication. Mobile wireless technologies have experience various generations of technology evolution, namely from 0G to 5G. Current research in wireless mobile communication technology focused on advance implementation of 4G technology and 5G technology. Each generation have some standards, different capacities, new techniques and features which differentiate it from the previous one [1]. 0G is also known as mobile radio telephone system phase and pre cellular phase. 0G systems included PTT (Push to Talk), IMTS (Improved Mobile Telephone Service), MTS (Mobile Telephone System), AMTS (Advanced Mobile Telephone System), OLT and MTD [2]. In 1980's, 1G technology featured mobile radio telephones and such technologies as Push to Talk (PTT), Mobile Telephone System (MTS), Improved Mobile Telephone Service (IMTS), and Advanced Mobile Telephone System (AMTS) [1]. 2G uses digital signals for voice transmission and support services such as short message services (SMS), picture messages and multimedia message services (MMS). The 2G standards are GSM, ident, D-AMPS, IS- 95, PDC, CSD, PHS, GPRS, HSCSD, and Widen [3]. 2.5G-General Packet Radio Service (GPRS) includes shorter setup time for ISP connections, and the possibility to charge by the amount of data sent, rather than connection time [2]. 2.75G-EDGE (EGPRS) technology is preferred over GSM due to its flexibility to carry packet switch data and circuit switch data [4]. The popular 3G standards are CDMA 2000, UMTS, TD-SCDMA, and WCDMA. Along with voice communication 3G network includes data services, access to videos and television, fax, audio/video conferencing, e-mail, web browsing and navigational maps. 3.5G – HSDPA (High-Speed Downlink Packet Access) provides packet based data service, improved speed and quality of downlink with data transmission up to 8-10 Mbit/s over a 5MHz bandwidth in WCDMA downlink [4]. 3.75G – HSUPA (High-Speed Uplink Packet Access) provides higher uplink speeds up to 5.8Mbps it enhances the uplink speed by increasing throughput, capacity and decreasing delays.

The present generation uses data-optimized 4th- generation technologies, with the speed improvements up to 10-fold over existing 3G technologies. The main goal of 4G technology is to provide high speed, improved quality, more capacity, high security and low cost services for voice and data services, multimedia and internet over IP. 4G communicate at 100 Mbps for mobile users and up to 1 Gbps over fixed stations. 4G networks are defined as ones that support amended mobile web access, gaming services, IP telephony, cloud computing, high-definition mobile TV, video conferencing, and 3D televise. Here the user has freedom and flexibility to select any desired service with reasonable QoS and affordable price, anytime, anywhere. LTE (Long Term Evolution) and WiMAX (Wireless Interoperability for Microwave Access) are considered as 4G technologies.

5G stands for 5th generation mobile wireless communication technology and is going to be a new revolution in mobile market which will change the means to use cell phones within very high bandwidth. 5G network comprises of real wireless world which would support UWB, LAS-CDMA, OFDM, MC-CDMA, IPv6 and Network-LMDS. 5G technology can be called as the perfect real wireless world or World Wide Wireless Web (WWWW) with no limitations. The aim of 5G technology is to provide unlimited access to any information and the ability to share data anywhere, anytime by anyone for the benefit of the world. 5G technologies covers all the advanced features which makes 5G mobile technology most powerful technology and will be in huge demand in future [1]. 5G technology is the foundation access technology for IoT applications

Machine to machine communication has a significant role to play in emerging internet of things paradigm in years and decades to come. The emerging IoT- 5G scenario extends sensor based IoT capabilities to robots, actuators and drones for distributed coordination and low-latency reliable execution of tasks at hand. Security is one of the biggest challenges faced by Internet of Things. With devices becoming ubiquitous and pervasive in day to day lives necessitate reliable and secure algorithms.

It is estimated that in year 2020, 20 to 40 billion devices will be connected to the Internet as part of the Internet of Things. A critical bottleneck for realizing the efficient IoT is the pressure it puts on the existing communication infrastructures, which transfers enormous data volumes [5]. This paper brief about the future of 4G and 5G technology in the era of IoT

## II. LITRATURE SURVEY

4G technology is still relatively new that provides high speed data rate to mobile devices. It consists of the LTE and WiMAX network. 4G wireless networks are prone to various security threats due to the open nature of the architecture and its standards. There are different technologies are used in 4G wireless technology are smart antennas for Multiple-input Multiple Output (MIMO), IPV6, VoIP, OFDM, Software Defined Radio (SDR) System. 4G technology consist of several security issues such as Interference, Scrambling Attacks, signal Jamming, Key management, Bandwidth stealing, Denial of Service attacks, Location Tracking and open Nature[6].

5G technology will provide very high bandwidth to the cell phone users. 5G communication represents the major phase of mobile telecommunications standards which is beyond the 4G/IMT-Advanced standards. 5G technology includes various features such as better camera, MP3 player and recording, video player, large phone memory, audio player, improved dialing speed, and much more which was never were imagined. 5G technology is going to be a new revolution in the next wireless mobile communication. 5G technology has high data capabilities and has ability to tie together unrestricted call volumes and infinite data broadcast within the latest mobile operating system [4]. 5G technology has a bright future because it can handle best technologies and offer priceless handset to their users.

In 5G Network Architecture all IP based mobile applications and services such as mobile health care, mobile online banking, mobile government, mobile portals, mobile commerce and others, are offered via Cloud Computing Resources (CCR). Cloud computing is a model for on-demand network access to configurable computing resources such as networks, computation, applications, servers, storage, and services [7]. The core network is a convergence of the cloud computing, telecommunication, nanotechnology and radio, and based on All IP Platform. The 5G technology distributes internet access to nodes within the building and can be deployed with union of wired or wireless network connections. The various trends of 5G technology has a glowing future. Lower battery consumption, better exposure and high data rates at the cell edge, multiple parallel data transfer paths, around 1Gbps data rate in mobility, better cognitive radio/SDR security, cheaper traffic fees due to low infra structure deployment costs, higher system level spectral effectiveness, support World Wide wireless web (WWWW) and more applications combined with artificial intelligent (AI) are some of the requirements of 5G technology [8].

The 5G technology presents the high resolution for sharp, passionate cell phone and give consumers reliable and fast Internet access. It also provides billing limit in advance. The technology provide carrier distribution gateways to unprecedented maximum stability without delay [9]. 5G network have high speed, high power, and low cost per bit, which intern supports interactive multimedia, virtual reality, video streaming, Internet, and other broadband services, more effective and attractive, bidirectional and accurate traffic statistics. In 5G, vertical handovers is avoided since it is not feasible when there are many technologies, operators and service providers are involved together. Here each network will be responsible for handling user-mobility, while the terminal will make the final choice among different mobile access network providers for a given service. The remote diagnostic is a great feature offered by 5G, through which a user can get better and fast solution [10] Forward looking view of the convergence of IoT, cloud, big data, SDN technologies along with the arrival of 5G mobile broadband networks is presented in [11]. IoT is capable of generating Big Data with volume, velocity, variety and veracity. Cloud is brought in for Big Data storage and processing. Then, SDN is employed to provide more efficient and flexible networks for inter-Cloud data transport. It demonstrate the technical relationships of those technologies and the compelling programs and applications that can be created when these technologies are converged.

**Role of 4G**

A 4G technology does not support traditional circuit-switched network, but all-Internet Protocol (IP) packet-switched networks which giving mobile ultra- broadband (gigabit speed) access. The first-release standards for 4G is Mobile WiMAX and LTE, which support much less than 1 Gbit/s peak bit rate. WiMAX has its origin in the cellular internet connection access. LTE is a wireless broadband communication technology designed to support Internet access via cell phones and handheld devices [12].

Worldwide Interoperability for Microwave Access (WiMAX) provide multiple Media Access Control (MAC) and Physical Layer (PHY) options. WiMAX is describes as a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL. Mobile WiMAX has improved security aspects compared to that of LTE in mobile enterprise networks. Also the efficient deployment speed, high data rate and the low cost are advantages of Mobile WiMAX. Long-Term Evolution (LTE) is a standard for high-speed wireless network for mobile phones and data terminals, which is based on the GSM/EDGE and UMTS/HSPA technologies. It increases the speed and capacity using a different radio interface together with core network improvements. However, due to marketing pressures and the significant advancements that WiMAX, Evolved High Speed Packet Access and LTE bring to the original 3G technologies, ITU later decided that LTE together with the aforementioned technologies can be called 4G technologies.

Mobile WiMAX Release 2 and LTE Advanced (LTE-A) are IMT-Advanced compliant backwards compatible versions of the above two systems, and promising speeds in the order of 1 Gbit/s. LTE-Advanced and WiMAX R2, are being designed to meet the same guidelines for IMT-Advanced which calls for an adaptive framework that can be used from local area fixed networks to large scale mobile networks and to use multiple carriers across multiple bands of spectrum[13]. Using Mobile WiMAX Release 2, low mobility users can aggregate multiple channels to get a download throughput of up to 1 Gbit/s. WiMAX R2 concentrate on proximate of multiple radio gain access to technologies and features such as link aggregation and load balancing [12]. LTE Advanced (Long Term Evolution Advanced is submitted by the 3GPP organization to ITU-T. The goal

of 3GPP LTE Advanced is to reach and surpass the ITU requirements by supporting long battery life and lower cost. LTE Advanced is essentially an enhancement to LTE. This cost effective upgrade path makes vendors to offer LTE and then upgrade to LTE Advanced which is similar to the upgrade from WCDMA to HSPA. LTE and LTE Advanced will also make use of additional spectrums and multiplexing to allow it to achieve higher data speeds. LTE-Advanced and WiMAX 2 can used up to 8x8 MIMO and 128 QAM in downlink direction.

Support for IoT requires Machine-to-Machine (M2M) communication. M2M is defined as direct communication between devices without the need for human interaction using communication channels. This may be data communication between devices and a server, or device-to-device, either directly or over a network. Examples of M2M services include security, smart grid, payment, tracking and remote maintenance/monitoring. Machine to machine (M2M) is the basis for internet of things and these can be invariably deployed in 4G communication standards. For LTE-based IoT networks to succeed, they need to have long battery life, low cost, support for high volume of devices, enhanced coverage (better signal penetration through walls for example), and long rage/wide spectrum.

All-inclusive nature of LTE's all IP architecture makes it ideal for IoT applications. LTE provides built in security along with reliable, robust and scalable traffic management capabilities in IoT. Since LTE is significantly more spectrally efficient than 2G or 3G, transporting data over a 4G LTE network can be done at a much lower cost per bit. The rate at which LTE is being adopted for IoT devices is astounding. LTE embedded in security cameras, utility meters, health monitoring devices, automobiles and public safety systems, and new applications are being invented and deployed. 4G LTE to meet the growing requirements of IoT applications, it should support the increased traffic carrying capacity, network efficiency, scalability, low latency and improved building penetration. The key benefits of 4G LTE that put mobile operators at a distinct advantage in the IoT showdown include ubiquitous coverage, faster, more efficient, better service and reliability. However, deploying and managing IoT solutions has its challenge not the least of which is security. 4G LTE offers enormous advantages as the transport network provides robust, high speed, reliable and readily available connectivity. This supports millions and, eventually, billions of devices sharing connections, transmitting data and connecting back to core networks. LTE supports IoT, while LTE-Advanced in favor of IoT extends device battery life to ten years with a power saving mode. LTE-Advanced Pro further optimizes coverage, device battery life and costs, as well as capacity for a massive number of connected devices with the introduction of two new technologies: eMTC (enhanced Machine Type Communication, often referred to as LTE-M) and NB-IoT (NarrowBand-Internet of Things). NB-IoT has reduced device bandwidth of 180kHz in downlink and uplink, and reduced throughput based on single Physical Resource Block (PRB) operation to enable lower processing and less memory on the modules. The LTE evolution for LTE-M and NB-IoT will enable cellular IoT for lower power, lower cost and wide area deployments that provide long lasting battery life through power saving mode and eDRX, low device cost by using simpler devices, low network deployment cost by enabling shared carrier capacity, full coverage via new coding, repetition and boosting power spectral density and optimized core network for IoT.

**Role of 5G**

5G networks must accommodate many more users and devices while delivering more data to each user at any instant in time. 5G is described as the first network designed to be scalable, versatile, and energy smart for the hyper-connected internet of everything world. 5G will enhance existing and expand to new use cases. It support Enhanced Mobile Broadband, Wide Area Internet of Things and Higher-Reliability Control. Enhanced mobile broadband ensures the next era of immersive experiences and hyper-connectivity with high throughput, low latency and uniform experience. Wide area Internet of Things optimizes toward the goal to connect anything, anywhere. Higher reliability control enables new services with highest reliability, lower latency communication links and higher availability.

A flexible 5G network architecture provide multi- access core network, dynamic creation of services, flexible subscription models, dynamic control and user planes, Modular, specialized functions and Configurable end-to-end connectivity. The explosion of devices connected to the Internet has been dubbed the Internet of Things (IoT). These devices may incorporate sensors to measure pressure, temperature, or stress and perhaps include actuators to turn on and off devices or make adjustments in real time. 5th generation wireless systems (5G) are on the horizon and IoT is taking the center stage as devices are expected to form a major portion of this 5G network paradigm. IoT technologies such as machine to machine communication complemented with intelligent data analytics are expected to drastically change landscape of various industries. The emergence of cloud computing and its extension to fog paradigm with proliferation of intelligent `smart' devices is expected to lead further innovation in IoT.

IoT requires various technologies and standards, such as sensors and actuators, wearable computing, communications and protocols, network, storage and computing infrastructure, and varying data and analytics.

Integration and automation of everything from home appliances to entire factories, small busty packets of data to and from large number of end devices as well as large data packet transfers. The key requirements resulting from M2M communications on the access network are adaptable Quality of Service (QoS) support, significant increase in spectral and network efficiencies, high system capacity, massive device connectivity, along with handling of small to large devices with varying traffic characteristics, range of low to high communications bandwidth, significantly reduced latency, high integrity and energy saving [11].

Achieving high energy efficiency in communications is crucial to IoT devices, typically relying on either small batteries or on harvesting technologies. This is even more important to application scenarios involving remote areas, which are difficult to reach and make it hard or almost impossible to recharge or replace the objects power supply. In this regards, energy-efficient networking solutions are being introduced in 5G, to account for the stringent battery constraints of sensors and actuators. These tend to exploit local communication to reduce transmission power consumption and/or data aggregation to lower the amount of data exchanged.

The huge number of smart devices, willing to connect to form IoT world, draws the researchers' attention on issues that may result challenging for current network infrastructures. The intrinsic dynamic nature of wireless IoT ecosystems requires guarantees of system continuity also in harsh conditions, including lack of the network infrastructure connectivity. In fact, a connection failure could cause tremendous consequences for critical use- cases, such as safety road data dissemination, health alarm systems, and automated industrial processes. Also, real-time interactive application, e.g., multimedia IoT, could undergo a significant reduction of user quality of experience. Therefore, advanced and reliable IoT systems

shall foresee a high-level network recovery capacity, quickly identify connectivity failures, and automatically establish alternative communication paths [12].

The IoT is populated by highly heterogeneous objects, each one providing specific functions accessible through its own dialect and network. However, to support the extremely differentiated IoT application scenarios, 5G cellular networks need of effective mechanism to handle heterogeneous data handling capabilities, flexibility in managing different radio technologies, integrated mobility management, etc. This 5G networks will be faster but also a lot smarter network.

### III. CONCLUSION

Our paper provided an insight into the role of 4G and 5G in realizing Internet of Things. IoT is definitely going to drive the business and technology in the coming future. Though lot of research is going on around the globe in different fields like 4G, 5G and IoT, the integration of all these key technology is a major challenge. We need M2M protocols to make devices intelligenzt. But the success of IoT definitely depends on the deployment of 5G infrastructure. Broadband wireless is the major carrier to send IoT traffic. Hence Telecommunication advances play an important role in making the IoT applications practical.

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