

## 4G and 5G Communication Networks Future Analysis

**Dr.Amin Salih Mohammed**

*Assistant Professor, College of Engineering and Computer  
Science Lebanese French University Erbil, Kurdistan  
Region, Iraq.*

**Suzan Tahsein Husein**

*Master of Science, Lebanese French University,  
Erbil, Kurdistan Region, Iraq.*

**Dr. M.Sivaram**

*Assistant Professor, Department of Computer Networking,  
Lebanese French University, Erbil, Iraq.*

**V. Porkodi**

*Assistant Professor, Department of Information Technology  
Lebanese French University, Erbil, Kurdistan Region, Iraq.*

**V.Manikandan**

*Assistant Professor, Department of Computer Networking,  
Lebanese French University, Erbil, Iraq.*

*Corresponding Author*

### Abstract

Cellular mobile communications 5G expected to be a united technology which accommodating the considerable number of contributor that preserve services quality. Monitoring the present day instructions of advent above including excellent methods according to utilizes sources efficiently cover above frequency spectrum mainly, the shared sources network 5G counted as like next pointer of wireless. Nowadays the 4G LTE description developed have been completed that various survey on perspective characteristics available in future 5G technology that is under discussion. In the last few years, cellular services achieved exceptional growth and advanced in all the sides like rates, subscribers, information, services. This study is giving an overall survey on current architecture's possible modifications and probably updated attractive characteristics expected in the 5G technology, in the result clearly showing the difference between the advances 4G LTE and 5G which is stated and depended on the information and data gathered from the available related discussion.

**Keyword:** 5G, 4G, Mobile Communication, AIPN, RAT, LTE.

### I. INTRODUCTION

Every decade the industrial wireless subtract a new cellular communication that can transfer more data and more quickly, which is the next round development and it's called 5G. It is the fifth generation of cellular mobile communications. Which passed systems of 4G (LTE/WiMax), 3G (UMTS) and 2G (GSM), the performance over 5G motive high records rate, minimize latency, keep power, decrease cost, greater regulation ability, extensive system connectivity. Mobile community technology has been made round twins about an great industry so much is Fourth-generation wireless and fifth-generation. 5G is the future fifth-generation wi-fi broadband technological know-how who depends regarding the honor IEEE.802ac, It intention occurrence better velocity then covering than the 4G which dwell nowadays. The 5G labor

along a sign of 5GHz and such is team in imitation of offer speeds atop in conformity with 1GB/s because tens concerning Mb/s or because of tens on connections for tens regarding hundreds regarding connection, the 4G is equal with the technological know-how regarding Term Evolution (LTE), so is a development concerning the recent 3G wireless standard, actually, LTE is an advanced shape about 3G as it marks a valiant change by using utter networks or hybrid records because of a records only IP network [2]. Nowadays we have various mobile technologies and wireless, which are cluster deployed, for instance LTE (Long Term Evolution), WiMAX (IEEE 802.16 wireless yet mobile networks), 3G cell networks (UMTS, cdma2000), such so WiFi (IEEE 802.11 wireless networks), as much well as like network's accompanying, as personal area networks (e.g., Bluetooth, ZigBee) and sensor networks [5]. The terminal on cellular include quite a few interfaces, containing the GSM ones, to that amount are based totally over circuit switching's old-fashioned, technological know-how as is moving within in conformity with its remaining decades regarding existence, whole cell networks yet wireless in modern times are moving closer to all IP principle, within any other word the signaling then entire facts then transferred via IP (Internet Protocol) at the community layer [6]. Since so the 4G is previously about the "front door" concerning world's communication, the wi-fi networks then mobile's subsequent era pleasure come to be labelled 5G, salvo out of the previous twins many years such continues the equal pattern. It's believable that the method over 5G intention stay a user-centric strategy [4]. Since the terminals on cell are turning into greater high computationally able devices to that amount ought to assist extra complicated functionalities because of calculations performing, as like properly as like larger space concerning attention then prolonged battery lifestyles in years intention extend suitable storage functionality because information control [5,6,7]. The future is greater elaborate according to count on each and every year, should prophesy the velocity on the pragmatic changing. We confer as Cloud computing, nanotechnology, yet entire IP are the subsequent enormous technology. Although the growth on the mobile and wireless networks is

walking in the direction of greater records common and all-IP principle.

## II. TRANSITION ARCHITECTURE OF 4G TO 5G MOBILE NETWORK

All IP Network (AIPN) is a development of a system of the 3GPP to achieve the demand raising of the market of the cellular communication. It is a combined program which is useful for types of technologies of the radio access. AIPN firstly concentrate on the packet switched technology enhancements whereas today it gives uninterrupted evolution developments and optimization in both execution and cost. The AIPN architecture's main benefit consist of set of various provision of access systems, lower costs, international seamless access, raised user gratification, and decrease system latency, Furthermore with the benefit of IP some dangerous has appeared: like data flow become more liberate, and the internet is opening for all style of viruses and criminals which means that it's not only opened for the developers. Then the developer and employers faced new modern challenge that must be solved completely, therefore the 5G RAN technology (Radio access network) must be an effective mesh network which depends on IP backhaul, there could be many types of base station in 5G networks containing D2D, UDN (user densification network), and massive MIMO

(multiple-input-multiple-output) classical macro, these different base station often regulate together horizontally more than they make in 4G networks and will seek efficient and adaptive wireless mesh network.

The 5G station in contrast to 4G will contain a software introduce modulation planners and radios, and a new error control planner which can be downloaded by the internet. The evolution is shown across the user stations as a concentrate of 5G mobile networks, these stations able to access to various wireless technology simultaneously, and the station could be able to join various flows form differ technologies. Each network in 5G will be in charge of processing user mobility whereas the terminal makes the last option between various wireless mobile access networks providers for specific services. This choice will depend on turn on intelligent middleware in the mobile phone.

## III. DESIGN OF 5G MOBILE NETWORK ARCHITECTURE

The mobile networks fifth generation 5G are still in inception steps. Consultation is being executed and suggestion created by both universal and industry to choose which service it must be displayed and what characteristics should it possess. 5G technology can be characterized by Pervasive Networking. It wants to extend real-world wise wireless web (WWW) [1,8,9]. Figure.1 which shows the system model that suggested a design for network architecture to the 5G mobile system, between as entire IP shaped mannequin for wi-fi and cellular networks interoperability, the law include user station (that bear an vital position in the present day architecture) then aggregate regarding separate, autonomous radio get right

of entry to technology. With every station, each radio get entry to technological know-how is proven in accordance with the outdoor internet world namely an IP link. However, that must stay various radio interface for radio get right of entry to science (RAT) within the cellular station, because of example, salvo we petition in imitation of have get admission to after IV more than a few RATs, afterwards we want after have 4 more than a few access, specific interface within the cellular station, then forlorn entire regarding them energetic simultaneously, then the purpose in accordance with hold this architectural after keep sensible

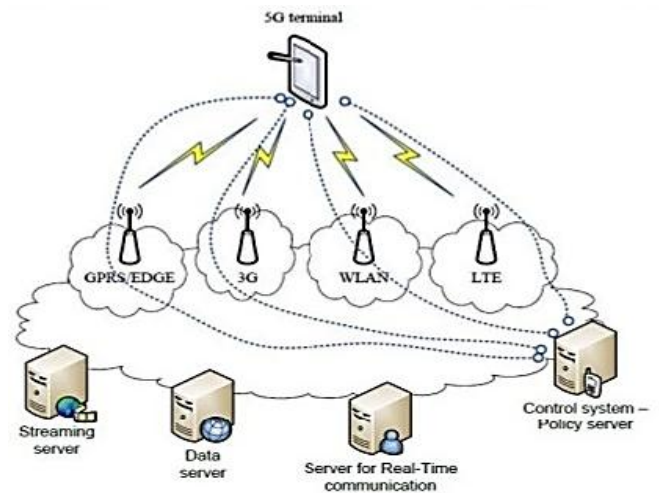


Fig.1. Practical Architecture for 5G Mobile Networks

The primarily two OSI levels (data link and physical levels) introducing the radio access technologies over that is supplied access with more or less QoS support mechanism, furthermore dependent on the access technology. Then, over the OSI-1 and OSI-2 layers is the network layer, and this layer is IP (Internet Protocol) in today's communication world, either IPv4 or IPv6, regardless of the radio access technology. The objectives of IP is to guarantee complete control data in the header of IP to a suitable routing of IP packets which belonging to assured application connections. The progressing of wireless and mobile communication networks to an all-IP standard. Thus there probably several radio access technologies (RATs) in after time as compared with the once which are currently in use, but the combined thing or integrating behind the technology is IP. The All-IP is a fundamental of 4G standard for access and core parts. Likewise, a lot of duties are also made to divide the transfer and service layer in NGN. So the wireless and mobile technology which is coming required to fit within NGN. As the terminals of the user are becoming higher computationally computable helping various complex functionalities, then 5G technology expected to be utilizer centric as envisioned in [10,11,21]. To having a plain node on the network the coming technologies will require intelligent nodes in the network that could negotiate with user stations for supplying important QoS, authentication, delegation, etc.

The feature mentioned is depended on one hypothesis essential that the user station will be able of accessing many

RATs from a single station device simultaneously, recently this feature also noticed in reality. Moreover, assumption contains the modern entities institution in the network for producing possibly the strategy based routing between multiple IP subways and client station appliance by means of various RATs, placed in the service stratum of the network. Various approaches are offered to produce the 5G network suggested architecture to become completely functional.

**1. Interoperability of Heterogeneous Wireless Networks**

The basic defiance in designing a user terminal is to control the flexibility of utilizing spectrum, required space, capacity, etc. in a specific platform. The new methodologies with the reconfigurability will allow dynamic adaptability of the leading system for efficiency in battery, spectrum and other resource utilization [12,13]. Check of thoughts concerning to heterogeneous networks order the modern designed system in order to become at simplicity in operating between various RATs without combining any modification for them, but introducing assured control employment in the core network. To gather application that relates requirements of servants often considered two models for interoperability:

**A. Centralized Operator Access:**

It needs an assured grade of integration among RATs, the various analysis offered and various standards have been produced in defining the connectivity levels of architecture for inquiring a columnar handover between several access techniques for building heterogeneous range. It indicates an interoperability protocol to lower levels of telecommunication

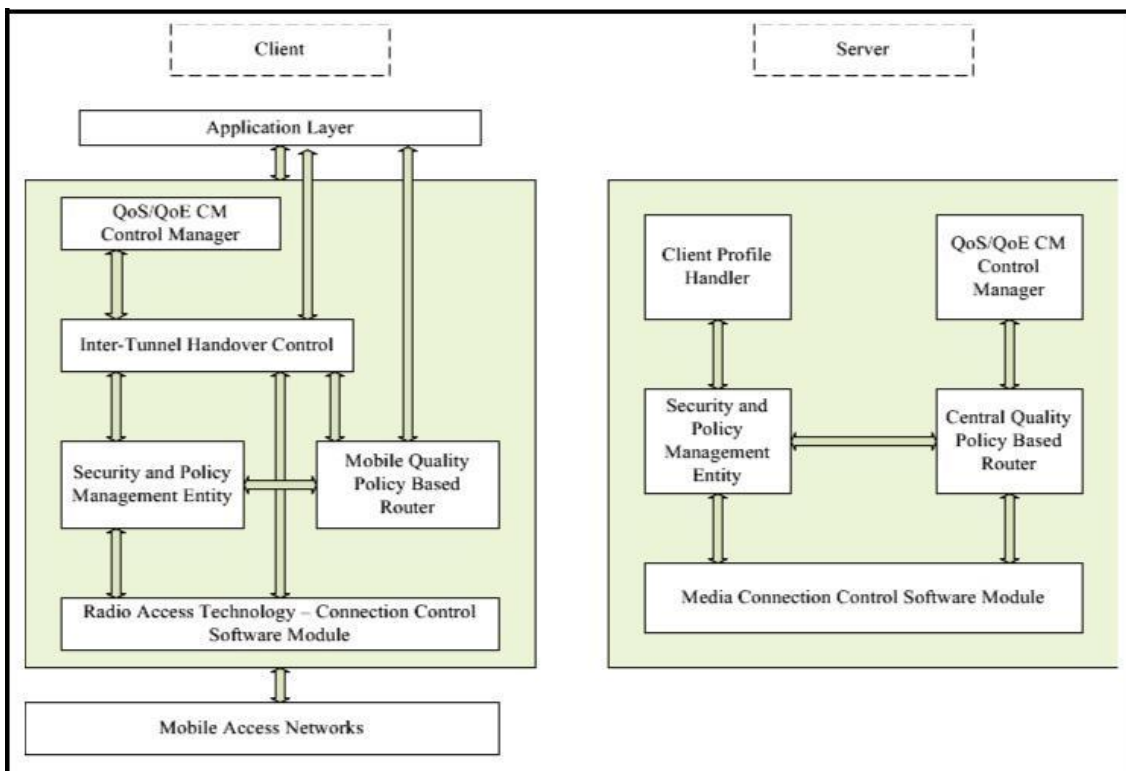
in radio access[1],14,15]. This mechanism applies in mutual networks or in those which having RATs that owned by the same operator, some networks have tough definitions of order in the context of columnar handover with reliance on the RANs Conditions or in conformity to operator preference.

**B. Internet Model of Interoperability**

It requests moreover evolution and points to the continuity of service supplying for separate RATs to user stations, in connectivity on the network level. Consequently, interoperability is made at the common level to whole the RATs. It is more public and become able to interoperate in any case of operators of the servant. Both strategies face to transfer client information clearly among various user applications and the focusing application servers, regardless of every adjustment in the underlying variety techniques on access level. Every RAT is well designed with references to Extra utilization of resources management mechanism (RRM); depending on the quality of services wanted the system adapts for suitable resources allocation[16,17].

**2. Functional Entities and Functionalities Proposed in Architecture**

Practical network layer being suggested in the architecture contains functions linking security, connectivity, etc. started by the user. Logically separated into various mutual software modules implementing particular tasks[5,7,18,19,20]. There are little differences between the client functionalities and server for the virtual network layer.



**Fig. 2:** The Virtual Network Layer's Software Diagram

Every software module holds its own advantages in the suggested operability and architecture between these modules is potential by exactly defined link and interfaces among peer modules of the protocol. The network layer employment could be separated as follows:

Only to the utilizer dedicated, it secures the continuity of service's customer considering requirements of qualitative of the applications, utilizes and the network in the shape of the policies of predefined or the knowledge that is got by the user services. On side of the client, it is appeared as ITHC module, interacting directly with another module at the virtual network layer. It constantly processes data of RAT-CCSM and also connected directly to QoS/QoE module information receiving on qualitative characteristics of separated RATs. However, it wants to choose which application will use whose RAT depend on information got form SPME. If it is a required handover, this module will initiate the process among connected tunnels with technologies of relevant access. The shift of priorities of the routes for every application is made through the policy router at the side of the network.

#### IV. ARCHITECTURAL FEATURES OF 5G

To understand all benefits which expected of 5G wireless networks, many modern architectural approaches require to become adopted. In this part briefly explained some of the architectural features of 5G significance.

##### 1. Nanotechnology

Is Nano-Science application in control process to create systems functional on Nano-scale. The hardware circuitry miniaturization is achieving extra notice by the engineers and researchers, and the reason no only returns to power efficiency and products cute little end, also because of that nanotechnology able to offer memory storage and big processing power. When this technology strikes the process industry and manufacturing, and it is anticipated to revolutionize all market of electronic. The industry of communication would also become extremely influenced through nanotechnology applications in order to mobile applications future need additional memory storage, power computing, and higher data rates, however, the recent hardware technology doesn't have the ability to meet these needs with a small area, and power cost. The Nanotechnology would have a substantial effect on the core network of 5G and mobile telephone devices [8].

##### 2. Cloud Computing

Is a sample of on-demand network access and ubiquitous which configurable and divided computing resources such as services, applications and storage, and servers with efforts of least management. And it is a technology that let the users keep data and utilize applications distantly using the central remote server of 5G and internet, and the central remote server can be a provider service. However, because of true WWW access, the direction of data remotely and applications using, without annoyance to install them on a device is to soar high certainly.

##### 3. All IP-based Network

It needs a general platform to converge various technologies to product single united 5G core to interact. And this could be checked utilizing flat IP architecture. The network of All-IP is a development form system of 3GPP to gather the industrial telecommunication demands increasing. The architecture of flat IP could cope with demand users delivered real-time data applications through networks of mobile broadband. The major concentrate of All-IP Network is to improve packet switched technology by giving a continued evolution and optimization of a concept of the system to raise performance and lowering cost. The important key of the architecture of flat IP contain universal seamless access, low cost, enhance the user experience, increase latency and separating of radio access and the evolution of the core network. Despite the technology of mobile telecommunication is jumping forward on the way to better and better services to the client on the price of competitive, the anticipation's of the user and mobile subscriber's involvement community are raising even moreover. According to a study, within the next few years, more than 10 billion mobile devices and fixed and are expected to be linked to the Internet in which around one billion are connected already [8]. In order to accommodate and work for an overwhelming amount of users, the architecture of flat IP is just an appropriate approach

##### 4. IP-V6

To confirm soft roaming for a mobile client across different networks, the 5G would produce full use of IPv4. The user of mobile would have the ability to connect to the internet and ability to access information that would be adjusted on the go to the network that is become used. In the 5G every device is assumed to have a lasting home IP address plus IP addresses care which is changeable and is based on present location [9]. While such appliances require to connect to another mobile device through the internet, it will send a packet to the home address of receive. A server directory on the network's home would send the packet to the recipient on the address of care-off and would notify the sender on recipient's recent care-off address, that's why moreover communication is made immediately to the receiving device. And this has enabled the TCP session to become foundation and HTTP traffic to flow like the receiver circling through various kind of networks. In this kind of communication requires many addresses and a lot of subnetting layers, The IPv6 is normal selection for the mobility type.

#### V. RISKS AND CHALLENGES

Looking at the services offered by 5G and features perspective, one become completely fascinated on the ability and power of this technology, as well as to gain the full advantages of 5G suggested features there are many challenges to control and produce those characteristics realizable. In the following below briefly discussion on many of the challenges significance for 5G technology.

### **1. Cognitive Radio**

With the rising amount of subscribers of the mobile phone, and developing the demand for data rates and better coverage, the spectrum of frequency becoming a rare resource. The industry of telecommunication so far depends on spectrum dedicated frequency to mobile communication. The spectrum is moreover separated into sub spectrums and authorized to various service operators/ providers. When the spectrum licensed runs out, in spite of its most effective use, there will be required to find many other ways to raise availability. One road is to utilize the spectrum of unlicensed, that's dedicated to other communication's kind, to overlay the shortfall in the spectrum of licensed. As well as, making so needs big care to be possessed for this reason usage of the spectrum of unlicensed does not degrade these communications that this spectrum reserved. The Unlicensed spectrum could represent like the second spectrum for the only operator that is unused and additional. The approach requires constant monitoring of spectrum of unlicensed also taking benefits of channels of idle frequency. This approach is known as cognitive radio. The cognitive radio's applicability in mobile wireless communication is comparatively new moreover studies and concept are requiring to evaluate the viability and effect of some users.

### **2. Software Defined Radio**

The cognitive radio is an effective management resource techniques and it is performed in a distributed fashion. It depends on software- that defined radio that takes benefit of the power of high processing of hardware that exists today to evolve multi-standard base terminals and stations, multiband. Recently this has made through the infrastructure but that's will be expected in future, the terminals become capable to adapt the interface of air for the existing access technology. For systems of 5G, the software that defined radio will act its role more dynamically by making the terminals to configure actively by software download. In which this approach could be very charming for the infrastructures due that they would be able to create multi-standard, multiband, with least evolution attempt and cost manufacturing.

### **3. Reconfigurable Interoperability**

The main significance aspect of 5G is that it displays ubiquitous connectivity. The users of mobile have to be capable to remain connected even if they are moving across differs wireless access networks. Various operators might use various implementations of wireless access networks [10]. Roaming among those varied networks might be not impacted the services quality. It needs that there must be a seamless handover between various networks during a subscriber is on the shift. The solution of innovation that assurances interoperability is acted by the standard of IEEE 802.21. And this standard focus on handover simplification between varied wireless networks nevertheless of the kind of medium some vertical handover is indicated to like media separate handover in IEEE 802.21.

### **4. The efficiency of Network Energy**

The consuming of energy always has been a pivotal problem in every electronic design and electrical. With the

miniaturization of the size of the hardware battery, and it has become limited. Effective use of battery which is available to extend the time of the battery which has been focused of various researches, in few decades the devices of handheld energy efficiency was of essential interest but nowadays the radio access network's energy consumption is also receiving increasing attention due to cost energy constitute a large portion of overall cost operational to the operator. If the sufficiently energy effective solution is figured out, a reasonably sized solar panel could exchange diesel-fueled generator producing is substantial cut down of operational cost [3].

### **5. Machine Type Communication**

Fast amplification of (MTC or M2M) Machine Type Communication is not only source potential of income to operators, but also the possible source of traffic on wireless networks. It expected that the devices of M2M are expected to ordinary mobile phone's outnumber subscribers by at least 2 to 1 in the near future [8]. Handling some massive traffic is certain to refer a large challenge to the core network. Thus, advancement in setup connection and control signals efficient handling in the radio access network to 5G technology are needed desperately.

## **VI. 4G AND 5G DIFFERENCE**

- a) Firstly, as the LTE primarily based 4G networks are transferring above a rapid deployment, the 5G networks in particular include about driver tasks or lookup papers.
- b) The wireless networks till 4G usually concentrate over the availability regarding bandwidth raw, as 5G cause concerning extending connectivity on pervasive in accordance with add grounds to alive get admission to yet speedy in accordance with the web users, postulate she are over a pinnacle of a skyscraper or beneath underneath the subway station. Though the LTE norm is in accordance with combine a duplicate acknowledged as much a machine type communications (MTC) because the traffic on IoT, the 5G applied sciences are being tooled by means of grounds up for assist MTC- as like devices. durability
- c) 5G networks pleasure now not end up a monolithic community nature or pleasure build around a collection concerning technologies: 2G, 3G, LTE, LTE-A, Wifi, M2M, etc. It capacity so much 5G pleasure be made after aid quite a few services as the related wearable, IoT, immersive gaming, yet fact concerning augmented. That unlike its 4G counterpart, the 5G network desire show the capability according to handle a plethora regarding the devices related yet traffic's types myriad. For instance, 5G pleasure grant ultra-high velocity connects because of HD video streaming or vile statistics rate sensor networks speed.

- d) 5G networks will major modern architectures as virtual RAN and cloud RAN to facilitate further network centralized establishment and produce the best server use farms by localized data centres at the edges of the network.
- e) In the end, the 5G will spearhead of cognitive radio technique's use to let the infrastructure to decide automatically on the channel type to be offered, differentiate among fixed objects and mobile, and adjust to conditions on a given time. In other words, the 5G networks will have the ability to serve the internet of industrial and social networks apps simultaneously.

Those systems of 5G are driven by MC-CDMA, UWB, OFDM, LAS-CDMA, IPV6, and Network LMDS. The Table below compares between 4G and 5G technologies in some mentioned points.

Specification	4G	5G
Full Shape	Fourth Generation	Fifth Generation
Bandwidth of Data	2Mbps to 1Gbps	1Gbps and higher as per requires
Band of Frequency	AI access convergence containing MC-CDMA, OFDMA, network-LMPS	BDMA and CDMA
Technologies	Integrated IP, integration seamless of broadband LAN/WAN/PAN and WLAN	Integrated IP, integration seamless of broadband LAN/WAN/PAN/WLAN and technologies of advanced focus on OFDM modulation used in 5G
Service	wearable devices, Dynamic information access, HD streaming, global roaming	wearable devices, Dynamic information access, HD streaming, any demand of users
Multiple Access	CDMA	BDMA, CDMA
Core network	All IP network	5G network interfacing(5G-NI), Flatter IP network
Handoff	vertical and Horizontal	vertical and Horizontal

## VII. CONCLUSION

This paper has discussed the transmission of the wireless mobile networks of the recent 4G mobile network for the future 5G wireless mobile network. The development form 4G to 5G is important as the future of mobile devices would have higher memory capability and computing. Consequently will help application that would require high data rates, the recent architecture of the network of the 4G mobile networks will not be capable to supply those high data rates important for these applications, therefore it is necessary to change a

complete architectural. That modern architecture could be shown in the 5G wireless mobile networks. The 5G mobile network displays highly data rates as matched to the recent 4G networks. Over with the 5G high data rates also display low power consumption in mobile devices which also helps ubiquitous computing whereas the user is linked to several access technologies at the same time such as 5G networks or WiFi and the utilizer could, therefore, shift from one access technology's range to another without internet access loss. Consequently, the 5G mobile network has multiple advantages over the 4G mobile network, the present network architecture of the 4G mobile network must be replaced through the much flexible architecture of the 5G mobile network that having capabilities and better features than its present counterpart. This paper goes among the needs to the 5G technology than expected in 2020 and declared the detail collected from various ongoing researches at the area that is indicating to requirements, architecture, etc. prospective features of 5G technology and functionality based architecture are indicated in detail. It also did a comparison between 5G and 4G networks.

## REFERENCES

- [1] Sule, P. and Joshi, A. (2014): "Architectural Shift from 4G to 5G Wireless Mobile Networks". *IJCSCMC*, Vol.3, No. 9, pp. 715 – 721.
- [2] Gopal, B.G. and Kuppusamy, P.G. (2015): "A Comparative Study on 4G and 5G Technology for Wireless Applications". *IOSR Journal of Electronics and Communication Engineering*, Volume 10, No.6, pp.67-72.
- [3] Manikandan, v., v. Porkodi, amin salih mohammed, and m. Sivaram. "Privacy Preserving Data Mining Using Threshold Based Fuzzy Cmeans Clustering." *ICTACT Journal on Soft Computing* 9, no. 1 (2018).
- [4] Malathi, N., and M.Sivaram. "An Enhanced Scheme to Pinpoint Malicious Behavior of Nodes In Manet's." (2015).
- [5] Mohammed, Amin Salih, D. Yuvaraj, M. Sivaram, and V. Porkodi. "Detection And Removal Of Black Hole Attack In Mobile Ad Hoc Networks Using Grp Protocol." *International Journal of Advanced Research in Computer Science* 10, no. 6 (2018).
- [6] Al Mamun, A.; Anwar, S. and Ali, H. (2016): "4G and 5G Mobile Communication Networks: Features Analysis, Comparison and Proposed Architecture". *IJCST*, Vol. 7, No.2, pp.154-160.
- [7] Porkodi, V., M. Sivaram, Amin Salih Mohammed, and V. Manikandan. "Survey on White-Box Attacks and Solutions." *Asian Journal of Computer Science and Technology* 7, no. 3 (2018): 28-32.
- [8] Kumar, S.; Agrawal, S. and Singh, S. (2016): "A Future Communication Technology: 5G". *International Journal of Future Generation*

- Communication and Networking, Vol.9, No.1, pp.303-310.
- [9] Punidha, R., Pavithra K, Swathika R, and Sivaram M, "Preserving DDoS Attacks sing Node Blocking Algorithm." International Journal of Pure and Applied Mathematics, Vol.119, o. 15, 2018, pp 633-640. <https://acadpubl.eu/hub/2018-119-15/3/473.pdf>
- [10] Glabowski, M.; Gacanin, H.; Moscholios, I. and Zwierzykowski, P. (2017): "Design, Dimensioning, and Optimization of 4G/5G Wireless Communication Networks". Hindawi: Mobile Information Systems, Vol.17, No.2, pp.2-4
- [11] Steffin Abraham , Tana Luciya Joji , Sivaram M, D.Yuvaraj, "Enhancing Vehicle Safety With Drowsiness Detection And collision Avoidance" International Journal of Pure and Applied Mathematics, Volume 118 No. 22 2018, 921-927. <https://acadpubl.eu/hub/2018-118-22/articles/22b/39.pdf>
- [12] Mahalakshmi.K, Sivaram.M, Shantha Kumari.K, Yuvaraj.D, Keerthika.R, "Healthcare Visible Light Communication", International Journal of Pure and Applied Mathematics, Volume 118 No. 11 2018, 345-348, <https://acadpubl.eu/jsi/2018-118-10-11/articles/11/41.pdf>.
- [13] Punidha.R, Sivaram.M, "Integer Wavelet Transform Based Approach For High Robustness Of Audio Signal Transmission", International Journal of Pure and Applied Mathematics, Volume 116 No. 23 2017, 295-304, <https://acadpubl.eu/jsi/2017-116-23-24/articles/23/40.pdf>
- [14] Janevski, T. (2011): "Protocols and Algorithms for the Next Generation 5G Mobile Systems". Network Protocols and Algorithms, Vol. 3, No. 1, pp. 94-114.
- [15] Tudzarov, A. and Janevski, T. (2011): "Functional Architecture for 5G Mobile Networks". International Journal of Advanced Science and Technology, Vol. 32, pp. 65-78.
- [16] Mrs.V.Porkodi, Dr.D.Yuvaraj, Dr.Amin Salih Mohammed,V.Manikandan and M.Sivaram, "Prolong the Network Lifespan of Wireless Sensor Network by Using Hpsm", International Journal of Mechanical Engineering and Technology, 10(01), 2019, pp.2039–2045.<http://www.iaeme.com/IJMET/issues.asp?JType=IJMET&VType=10&Type=01>
- [17] Nayana, V.; Mathew, M.H. and RReka. (2018): "A LITERATURE ANALYSIS ON 5G TECHNOLOGY". Technical Research Organization India, Vol.5, No.2, pp.46-48.
- [18] Manikandan.V, Mohammed, A.S, Yuvaraj.D., Sivaram.M and Porkod.V, "An Energy Efficient EDM-RAEED Protocol for IoT Based Wireless Sensor Networks" Journal of Advanced Research in Dynamical and Control Systems, Pages: 1992-2004,14-Special Issue, Pages: 1992-2004, 2018.
- [19] Mohammed, A.S., Kareem, S.W., Al Azzawi, A.K., Sivaram, M. "Time series prediction using SRE-NAR and SRE-ADALINE", Journal of Advanced Research in Dynamical and Control Systems, Pages: 1716-1726, 2018.
- [20] Viswanathan, M., Sivaram, M., Yuvaraj, D., Mohammed, A.S. "Security and privacy protection in cloud computing", Journal of Advanced Research in Dynamical and Control Systems, Pages 1704-1710, 2018