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Deep Learning On 5G Technology With Existing Technology

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ABSTRECT

In this work, an effort has been made to examine the performance, benefits, and drawbacks of the various generations of mobile wireless technologies that are currently in use. The paper discusses the creation and growth of several mobile wireless technology generations, as well as their significance and benefits over one another. Mobile wireless technologies have seen 4 or 5 generations of technological revolution and evolution in the last few decades, from 1G to 4G. The focus of current research in mobile wireless technology is on the advanced deployment of 4G and 5G technologies. While heterogeneous devices and technologies represent substantial dangers to 5G networks as compared to the previous generation of communication networks, 5G will provide a wide range of applications. In this post, we go through the crucial research issues surrounding security and privacy in 5G networks as well as the requirement for new security solutions for these networks.

Keywords—5G, Wireless Communication, generations of communication, technology, speed, latency, security, network, 6G Technology.

I INTRODUCTION

Integrity and secrecy of data being sent from a sender to a recipient in a mobile communication device are crucial. A method that enables the processing of encrypted messages in mobile communication devices could be utilised to give 5G legitimacy. The message must be encrypted and contain both the encrypted content and the encryption accessing information, allowing a mobile device to receive the message and store the encryption accessing information in its memory. When necessary, the mobile device will then retrieve the encryption accessing information from the memory, allowing the message to be decrypted and the message received to be read.

If there are multiple recipients, this can be advantageous because each one will check the signature before the message is decoded, creating a secure message key cache on a mobile communication device [1]. While the growth of electronic commerce is accelerating daily, payment methods have also evolved. Although credit cards are typically used for online purchases, a novel payment method that requires a mobile device or a wired/wireless acoustic response system (ARS) has recently been created. For the protection and security of financial data stored electronically

In a payment system, the user's authentication information and payment information are encrypted using a secure socket layer (SSL)-based system.

Secure electronic transaction (SET) is used to apply a double encryption to the security, preventing the leakage of payment information and creating a secure system. Today, mobile communication terminals are used to provide an authentication and payment system that authenticates based on the mobile terminal installed, which is a wire terminal, or is connected through a leased line, providing a safe and simple payment process[2]. For broadcasting targeted content information, like as commercials and weather reports, to a wireless communication device, like mobile phones and other wireless accessible stations, mobile targeted content message (TCM) systems are frequently employed.

Due to their disregard for content that is not pertinent to mobile communication, these technologies contribute to a better user experience. Mobile advertising can offer wireless service providers revenue streams that enable more affordable access to messages. To do this, a user profile should be chosen, and a message transportation schedule should be created [3]. Using a mobile network from a source that is in a public IP address network, a mobile user can communicate as a payment system agent to a secure device using a mobile network. It requires a mobile network server to accept the device's IP address from a mobile communication network junction.

With the help of these capabilities, the problem of sending messages to devices that must be located in either public or private IP address space will be resolved [4]. A mobile device has the capacity to store one or more emails or phone numbers for contacts. For security purposes, this feature is still in place. If a mobile phone is stolen or lost and the sim card is changed, the phone will check to see if the sim card is the same as the one that belonged to the owner of the phone. The IMSI numbers of the owner's sim card and the new sim card are compared to determine this. A tracking feature is turned on if the numbers are different from one another.

These features will help to overcome the issue of sending messages to devices that need to be situated in either public or private IP address space [4]. One or more emails or phone numbers can be stored on a mobile device as contacts. This function is still available for security reasons. A mobile phone will check to see if the sim card is the same as the one that belonged to the owner of the phone if it is stolen or lost and the sim card is replaced. To ascertain this, the IMSI numbers of the owner's sim card and the new sim card are contrasted. If the numbers deviate from one another, a tracking feature is activated.

The mobile device should be able to display one or more incoming video feeds on the current screen size if the video conference is multi-point. Mobile clients should also be allowed to conduct video calls with users who are not registered on the same video conferencing system. An occasional loss of data connectivity may leave a mobile device with only a phone connection. In this case, the conference server will automatically call the mobile device's number, allowing it to go on with the current conference. The mobile device rejoins the confessional session if the data connection is established again [6]. The privacy concern is the main one with 5G. There is a lot of anxiety about describing security and privacy on the 5G internet with a mini-track on both.

The focus of the mini-track is also on the economic values of end users' data that are redefined relationships between end users' interest in handling their personal data and legal business on data analysis on the basis of contemporary tools, to make those relationships profitable and morally correct. The biggest issue for their users is that 4G service is becoming increasingly sluggish, thus they are working to improve services and technology by concentrating on their main goals for the impending 5G technology. Due to the cellular network's efforts to improve its architecture and concentrate on the essential elements, 5G is extremely beneficial [7]. Because of various shortcomings in 4G technology, 5G is currently the fastest-growing technology.

By using a GPS trace system, this aids in a quicker resolution of the issue [8]. The primary factor that needs to be taken into account is how quickly data traffic is growing over time. Finding the right solutions for the ever increasing data flow is crucial. 5G has numerous advantages.

benefits. It offers the same services as a fiber-based wide-area network. The introduction of front-end femtocells, which are 5G-based and used for this purpose, has been highly beneficial in enhancing the performance of current LTE-Based radio access.

Its proposed infrastructure and planned model, which enable us to receive strong signals with low BER and very high data rates of 1 Gbps, are useful [9]. Design and modelling of a micro strip patch antenna operating system at 28GHz are part of 5G communication. The antenna's operating scenario is that its maximum reflection coefficient is 12.59 dB and it operates in the local multipoint distribution service band, which has a centre frequency of 27.91 GHz. The feed is the transmission line of the antenna, and it has a "bandwidth" of 582 MHz and a high gain of 6.69 dB. The foundation is "Rogers RT Duroid 5880" and it has a height of 0.25mm and a "dielectric constant" of 2.2. HFSS visualises, examines simulation results, and computes antenna

II. LITERATURE REVIEW

Wireless communication has evolved over the past three to four decades with each new generation providing an advancement over the previous one(s). Mobile wireless communication started with 1G, gradually evolved into 2G, 3G, 4G, and presently at the fifth-generation (5G).

In-depth information on how mobile wireless communication has changed from one generation to the next, including advancements made by each succeeding generation, was supplied by Mondal et al. [10]. The first generation (1G) was successful in establishing the fundamentals of mobile voice, while the second generation (2G) introduced the capacity and coverage of communication networks. In particular, 3G focused on boosting data transmission speed, which led to a "mobile broadband" experience that was later made possible by 4G. The objective of 5G is to offer user terminals that can access multiple wireless technologies at once. The communication systems that will come after 5G are likely to employ a satellite network. There is an assumption that the cost of mobile calls will be lower with 6G.

The model includes a user terminal, which is a crucial component of 5G design, as well as a number of separate, autonomous radio access technologies. Other than throughput, there must be substantial differences between 4G and 5G, such as higher coverage, lower battery usage, and high data rates available per unit area (high system spectral efficiency). With low infrastructure rollout leading to an increase in peak bit rate and higher cognitive radio security, 5G is predicted to offer a data rate of roughly 1Gbps in mobility, lower traffic tolls, and greater cognitive radio security. Additionally, a high capacity that enables more devices to connect simultaneously, more supporting devices, better connectivity regardless of the geographic region, and more are anticipated to have a high capacity that enables more devices to connect at once, a greater number of supporting devices, improved connectivity regardless of the geographic region, and increased communications reliability. [11]

Bajracharya et al. [13] propose using an unlicensed private 5g unlicensed network for connecting industries of the future. "New Radio in the Unlicensed band (NR-U) supports 5G advanced features of ultra-high-speed, high bandwidth, low latency, and improvement in the reliability of wireless communications, which is essential to address massive-scale and highly-diverse future industrial networks."

Cheng et al. [14] discuss Spatial division multiple access (SDMA) technology, Multi-beamforming technology & Heterogeneous Networks (HetNet) which can be novel networking paradigms to satisfy the requirements for using 5G in Industry 4.0.

Ding et al. [3] introduce us to multi-access mobile edge computing (MA-MEC) which is built on the stable foundation of mobile edge computing. As it brings the computational power closer to devices, it is a promising technology for implementing 5G components on an Industry 4.0 enabled shop floor. MA-MEC aligns with the evolution towards ultra-dense large-scale deployment of small-cells (micro/pico/femtocells) in future 5G private network or network slices. Zikria et al. [19] help us understand the term fog computing which was introduced by Cisco for edge computing.

Pace et al. [16] help us understand how augmented reality supported by 5G can enrich both the managers/supervisors' job and the workers' one. Data gathered using multiple sources all around the factory is continuously processed, saved and controlled either in the cloud or on the edge/fog depending on the use case and availability of infrastructure Gestures, voices, facial expressions (and many other features) are detected by smart sensors and stored with privacy considerations. Life-parameters or health-status can be monitored on the legitimate grounds of preventing any physical illness or accidents. Moreover, any mistakes by machines or humans made during any operation can be detected in real-time and promptly managed immediately but ideally proactively if cognitive analytics have been implemented.

II. NEW USER NEEDS

Life expectancy has increased over the past 50 years, and by 2020, there will be more people in their 60s than children under five. Italy comes in second place after Japan in the world for longevity [10], and the migratory phenomena only partially succeeds in slowing down the dynamics of the population's progressive ageing.

This has a significant impact on the health and welfare system since a rise in the elderly population and longer patient lives over time result in an increase in the number of chronic patients. With population ageing, the prevalence of chronic degenerative diseases rises: among those aged 55 to 59, 53% have a chronic illness, and for those over 75, the number rises to 85.3%. Nearly 1.5 million chronic patients live in the Tuscany area, making up 40.1% of the total population (the national average for Italy in 2017 was 39.9%).

Additionally, considering that more people than ever before suffer from many chronic illnesses, Comorbidity is the most common chronic condition (20.3%). It is now important to approach this issue from a different angle, one that is more focused on the person's entire clinical complexity as opposed to the treatment of specific illnesses. There are around 20000 more chronic patients in Tuscany than there were in 2018, which results in a higher commitment to the daily management of the disease, notably by local services [11].

User-centered health monitoring is widely utilised in healthcare and has grown in popularity as a result of its ability to help individuals manage their chronic illnesses and maintain good health [12,13].

In 2006, 2011, and 2016, the WHO Global Observatory for E-Health performed three global surveys on the e-Health phenomenon. It is becoming more and more obvious that eHealth assistance is necessary for the implementation of universal health coverage (UHC). At least one mHealth initiative has been reported by several nations (83%).

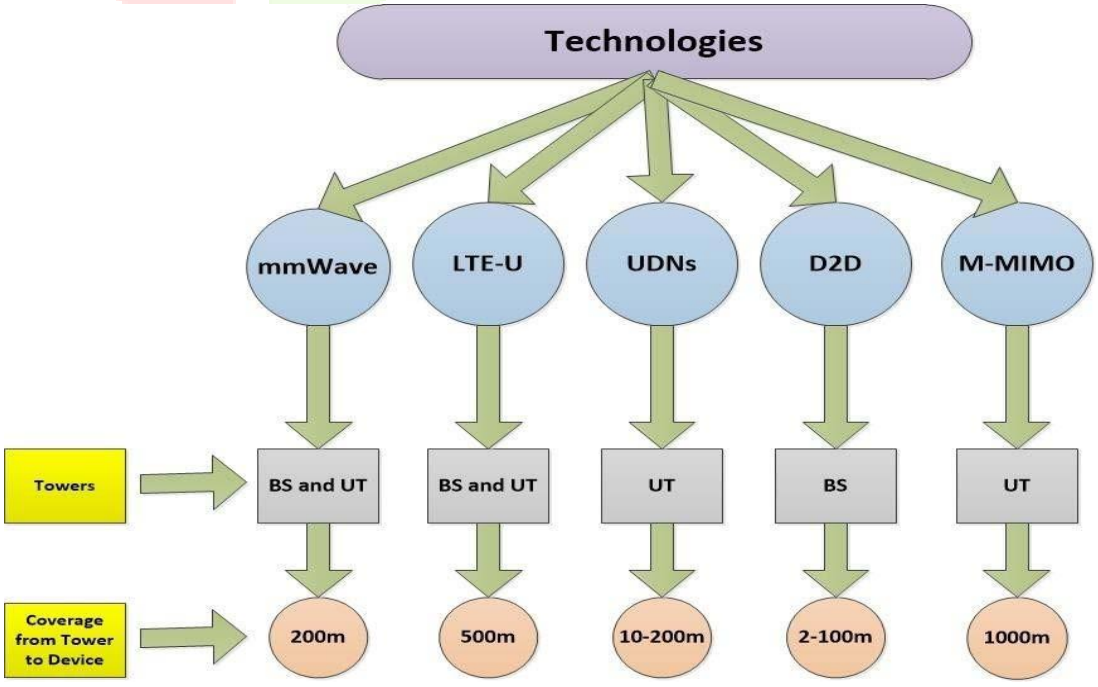
III. ENABLER OF 5G TECHNOLOGY

Several existing techniques serve as building blocks for 5G technology. They include [20]:

1. Evolution of Existing Radio Access Technologies (RATs): Rather than being a new RAT, 5G is a collection of RATs with novel and distinctive designs.
2. Creating Hyperdense Small-Cell: HetNet is a cutting-edge approach that can assist improve the area spectral efficiency (b/s/Hz/m2). Additionally, it meets the 1000x capacity crunch while simultaneously giving the system more Energy Efficiency (EE).
3. Possibility of Self-Organizing Networks (SON) a rise in the amount of tiny cells The SON's momentum grows with 5G.
4. Machine Type Communication (MTC): In this type of communication, one or both users must have access to machines in order to connect.
5. Millimeter-Wave RAT Development: Research into centimetre and millimetre waves for mobile communications is ongoing as the sub-3 GHz spectrum becomes more congested and conventional RATs near their Shannon's capacity limit.
6. Redesign of Backhaul Links: 5G is anticipated to redesign backhaul links to increase capacity for user traffic generated while radio access networks (RAN) are simultaneously being developed.
7. 7. Energy Efficiency (EE): Improving the design of energy-efficient techniques for RAN, User Equipment (UE), and backhaul links is crucial for the development of 5G.
8. New Spectrum Allocation is Required: This is essential because improving spectral efficiency or hyper-densification will not be able to handle the 1000x increase in wireless traffic that will occur over the next few years.
9. Spectrum sharing: This procedure is crucial in order to prevent the time-consuming task of monitoring the allocation of additional spectrum. Thus, alternatives to the conventional licenced or unlicensed allotment of spectrum can be adopted.
10. Network virtualization of RAN: This procedure is especially crucial since it enables the sharing of wireless infrastructure among several operators, allows for the combined management of wired and wireless networks from a single orchestration unit, and increases network efficiency.

ARCHITECTURE OF 5G

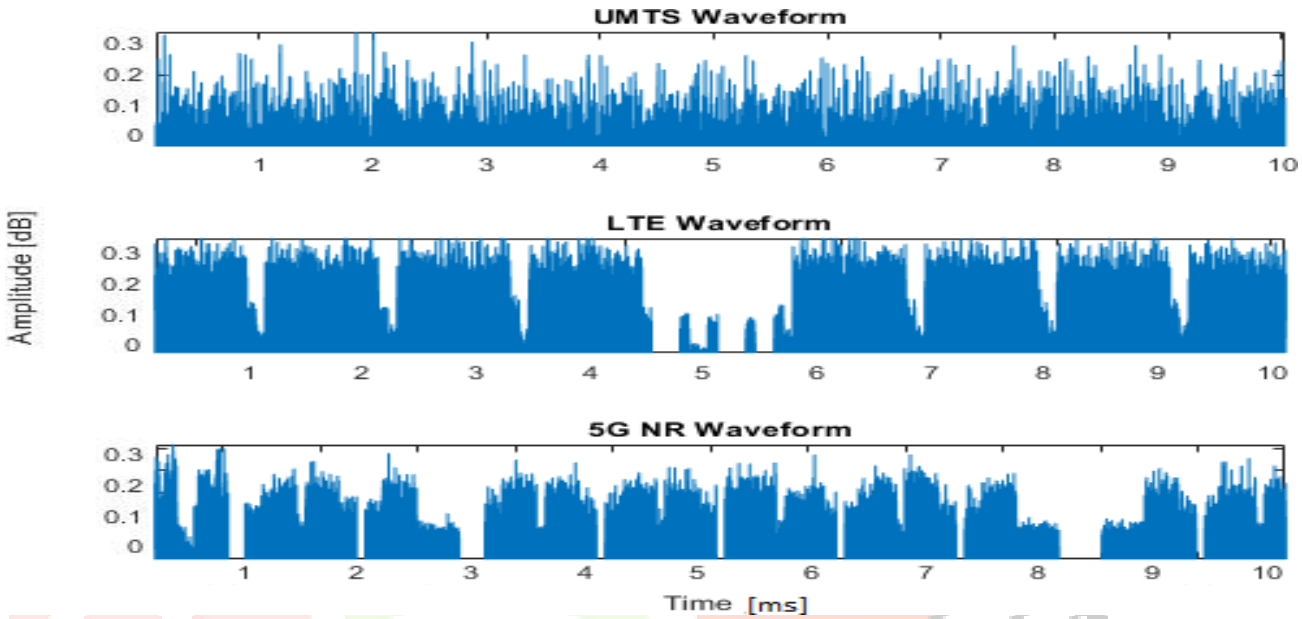
Technology for 5G is IP-based. It is the stage where radio technology can advance since there are sufficient numbers of devices connected. This technology will be optimised by employing IP-based radio connections. Mobile technology uses any secure paperwork because everything is controlled and protected.



The relationship between technologies and their corresponding approaches and constraints, which define the range of reaching the tower to device, are defined by the taxonomy mentioned above.

3G, LTE, AND 5G SIGNAL MODELS

As depicted in Fig. 1, we will introduce the three distinct signal types—3G, LTE, and 5G—in this section. In order to identify the signal type, we used deep learning algorithms to generate signals in a variety of settings (signal types, signal-to-noise ratio levels, fading, and dataset size).



3G, LTE, and 5G signal waveforms

3G

Third-generation (3G) wireless Universal Mobile Telecommu- nications System networks employ radio frequencies called UMTS frequency bands. Between 850 MHz and 1900 MHz, the UMTS frequency spectrum is used for 3G [21]. Fig. 2 displays the frame structure. Each of the 15 slots in the superframe, which is made up of 72 frames, has 2560 chips. Each slot in a 3G frame lasts 0.667 milliseconds, or 10 milliseconds, in total.

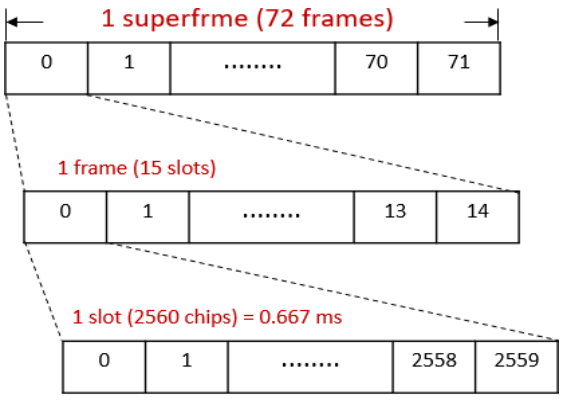


Fig. 3G frame structure

B. LTE

The frequency used by Long-Term Evolution (LTE) telecommunications networks is 700 MHz or 2600 MHz. The 10 ms-long LTE [22] frame structure is broken down into two subframes. In Fig. 3, the LTE frame structure is displayed. The length of an LTE frame is 10 ms.

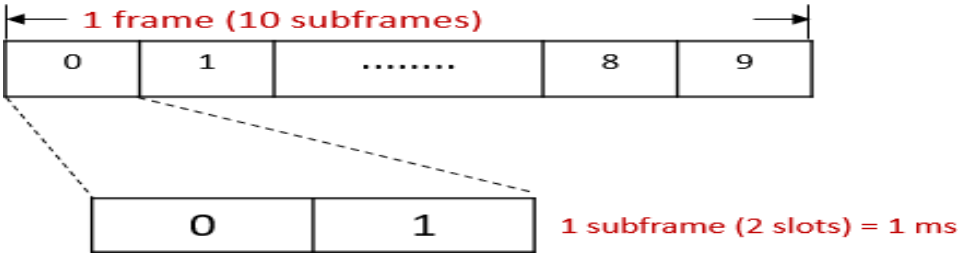


Fig. 3. LTE frame structure.

C. 5G

Figure 4 depicts the frame structure of a 5G signal [23]. Like LTE, a frame has a duration of 10 ms and is made up of 10 subframes, each lasting 1 ms. There are two slots in each subframe, and each slot has 14 OFDM symbols. The most noticeable distinction between 5G NR and LTE numerology (subcarrier spacing and symbol length) is that 5G NR offers a variety of subcarrier spacing variations, but LTE only supports one type. only one 15 kHz subcarrier type. Both the current LTE frequency range (600 MHz to 6 GHz) and millimetre wave bands (24-86 GHz) will be used by 5G. The maximum bandwidth and subcarrier spacing vary depending on the ranges. The greatest bandwidth in the sub-6 GHz range is 100 MHz, whereas the maximum bandwidth in the millimetre wave range is 400 MHz.

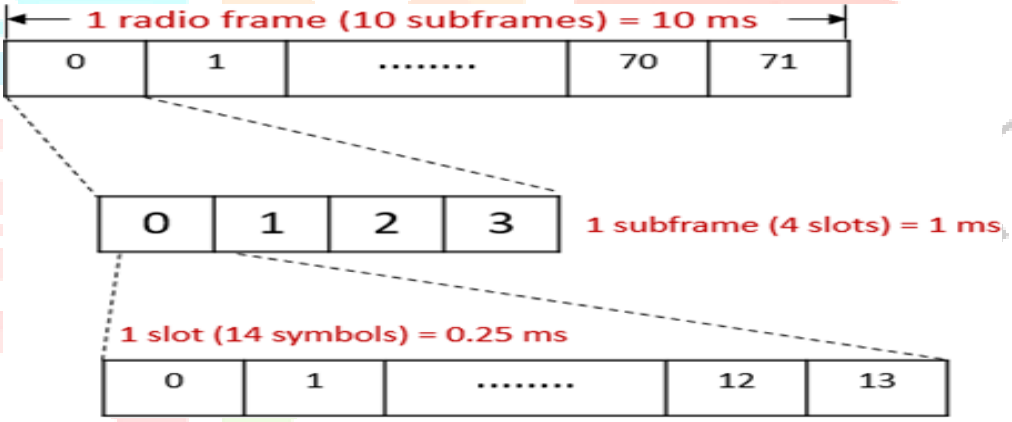


Fig. 4. 5G frame structure

CHALLENGES IN 5G EXPLORATION

Research obstacles may make this challenging, but by the time 5G is available, everyone will be able to get quality healthcare regardless of their socioeconomic status, region, or race. With the use of IoT, big data, AI, and machine language with high throughput and low latency, 5G will address and solve deficiencies in the existing healthcare system [24]. When it comes to large projects like the H2020 5G City, an infrastructure that aims to deploy a media network based on cloud, there has been an increase in the adoption of cutting-edge media services, for example, augmented reality where a user is allowed to add digital elements to their environment and virtual reality which changes the entire environment.

DIFFERENT TECHNOLOGIES OF 5G

5G technology depends on IP based. It is the stage where radio technology 5G technology allows transaction of many input and outputs connections [16]. Technology today isn't designed with low latency in mind, and therefore can introduce seconds or more of latency which can result in poor user experiences causing jitters. Many network applications demand ultra-low latency so "ULL networking mechanisms" contributed a lot the emerging 5G network access chain from "wireless devices" by access, and "core networks". The standards developed by standard committees namely, IEEE TSN IETF and research studies are organized and the current issues of the existing standards are put in front to enhance changes for the production of better results in the future [14].
Multiple Input Multiple Output (MIMO) technology will overtake all others as the most widely used method for telecommunication networks once 5G debuted wireless communication technology [18]. A user-centric perspective has been provided, which is attaining the predictability of the user everyday notions, to improve the user Quality of Service (QoS) in the 5G network. Agglomerative clustering is done with the use of cells to identify these ideas.

The HSR is a significant use of 5G technology; it frequently uses parameter channels based on straightforward scenarios. HSR essentially consists of three scenarios—"urban," "cutting," and "viaduct"—each of which has three distinct channel estimates. The creation of channel parameters via ray tracing simulation is carried out by Tapped Delay Line (TDL) models, which are thought to be the most practical. (LS), (LMMSE),and our proposed (HiBEM)".

According to authors, 5G offers the highest level of connectivity for router and switch technology [17]. The 5G wireless mobile network's primary driver is thought to be the new era of growing mobile data traffic [18]. With the usage of huge multi-user approaches and small geometries like millimeter-wave, the 5G mobile network has the ability to consider wireless communications and incorporate spatial multiplexing [19]. By utilising simple approaches, 5G made it possible for the internet of things to communicate more securely and connectedly [25].
The performance of the "(HiBEM)" model may be examined in terms of the "(MSE)" estimator, and the system output can be assessed using several channel estimates for each scenario. The research was confirmed by the simulation's findings. In the viaduct scenario, other estimators are outperformed by "(HiBEM)" estimators and the output of the systems [16]. Future demands from 4G service users for higher service quality and faster data rates will raise several primary goals' capacity [17]. "5G architecture" is a significant advancement in input, output, and device communication technologies.

5G IMPACT ON SOCIETY

Fifth generation networks have the potential to improve cell phone broadband services in rural areas from a social perspective. The extensive penetration of rural locations has been delayed because to the financial outlay for installing a large number of BS and the lower ARPU (average revenue per user) [38]. The placement of 5G networks in rural areas will be less difficult because to the use of TV White Space and the unloading of traffic elucidations. Budget thanks to more favourable propagation conditions in the very high-frequency/ultrahigh-frequency range that invariably result in smaller base stations

Opportunities and challenges

a performance ceiling, and further growth is anticipated to be minimal. As a result, 6G demands cutting-edge breakthrough technology as well as new theories and paradigms [28]. On the one hand, a large-scale 2020 IEEE International Conference on Integrated Circuits, Technologies and Applications antenna and ultra-dense network (UDN) correlate to a corresponding rise in interference. Massive MIMO in 5G can use straightforward linear operations to get rid of interference, however beamforming (BF) designs typically make a compromise between MIMO and BF. Traditional interference cancellation methods are therefore no longer the best option. Contrary to conventional wisdom, which views interference as a negative phenomenon, 6G will make use of interference as a resource for creating an energy-efficient, highly accurate holographic communication system. Currently, computational holographic interference exploitation has the highest potentialfor interference exploitation at the moment [28].

Comparatively speaking, 6G systems will use higher carrier frequencies like THz. The ability to instantly analyse and process RF signals over an extreme broadband of 100GHz or more in real time will be a significant problem for future radio systems. The photonics-defined system will provide an excellent 6G platform since it can deliver extremely broad bandwidth and potentially full spectrum capacity. The photonics-defined radio appears to be a logical progression to 6G in terms of a fundamental enabling technology.
Extreme broadband designs will be streamlined and optimised by photonics-based systems as a result of the full spectrum convergence of 6G mobile communication networks. As a result, interference exploitation and photonics-defined systems will become the new theories and paradigms of the 6G system.

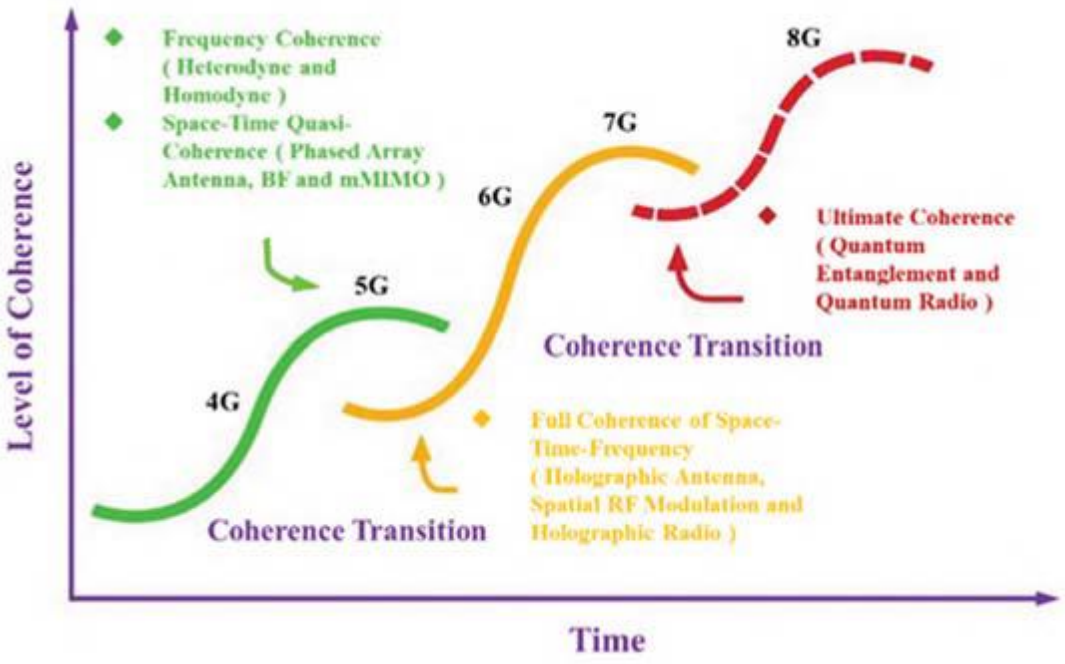


Figure1 The inherent logic and coherence transition of wireless evolution

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As a result, the paradigm change, technology-driven convergence, and new evolutionary logic will offer some guidance and fresh starting points for the design of future 6G networks, leading to a revolutionary physical layer technology of holographic radio defined by photonics. Holographic radio is now thought to significantly increase spatial multiplexing, producing holographic imaging-like, ultrahigh resolution, and pixelated spatial multiplexing as one of three primary prospective technologies for the 6G physical layer [5–6].

A. Privacy and Security

Gathering information from in- and on-body sensors and transmitting the collected data towards a cloud medical Centre for further analysis ask for new security solutions.

Achieving secure communication within and on the body currently represents an open research area, in particular due to the restricted energy consumption and compute capabilities of the body sensors. The main issues are caused by: i) the limited resources (power, computation, storage capacity, etc.) of nanodevices, which make the adoption of on-demand key distribution methods impractical and the implementation of pre-deployed key techniques challenging; and ii) the requirement for scalable networks in a nano-domain [26]. Therefore, new communication and security architectures as well as various energy-efficient authentication algorithms and reduced key length cryptographic techniques are needed. In the context of molecular communications, certain research have been conducted for both a preliminary assessment of the secrecy capacity in a diffusion-based MC system [27] and for the proposal of novel sources of encryption based on biological molecules (such as DNA and RNA). Further research is still required to deal with molecular spontaneous reactivity and unpredictable circumstances, particularly in nano-scale contexts.

CONCLUSION

This research report covered current 5G mobile communication methods. We evaluated and contrasted two data aggregation plans. Even yet, asymmetry faces some technical difficulties. However, we have talked about several implementation strategies for the 5G design phase.Future fifth generation wireless technology has been thoroughly studied. In this paper, we discussed the difficulties, enablers, and basic design principles of the fifth generation of networks, as well as their radio spectrum, ultra-dense radio access networks, traffic offloading of mobile traffic, cognitive femtocells, Wi-Fi & White-Fi, alternative solutions for offloading, cognitive radio, software-defined radio, software-defined networking, and social impacts. This study may provide a better platform for encouraging industry representatives, academics, and researchers to provide better outcomes about many problems and difficulties in upcoming fifth (5G) generation wireless networks.

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FUTURE SERVICES

Future assistance will be directed towards developing a medical science that views the human being as a holistic system and does not divide the various medical fields. In actuality, a person's lifestyle, including psychological, emotional, and even environmental factors, is always considered when treating an organ or a disease. Humans are viewed as a holistic system made up of their body and mind, and their overall health is not just dependent on how well each individual organ is operating.

The monitoring of all health indicators is difficult, according to this new holistic paradigm for evaluating a person's health status. For an always-on and mobile control, it is necessary to incorporate cutting-edge sensors both inside and outside the body. This calls for a "connective tissue" that is pervasive, dependable, safe, and adaptable; 6G technology might serve in this capacity. Future e-health services based on advanced monitoring of patients' vital signs, specific health indicators, physical activity, psychological aspects, and surrounding environment (multiple data sources) can significantly improve the provision of personalised health care by: i) facilitating the development of new and efficient highly customizable models of care; ii) making it possible to accurately and dynamically define care needs; and iii) identifying the most appropriate health services.

REFERENCES

[1] Little, Herbert A., and Michael G. Kirkup. "System and method for secure message key caching in a mobile communication device." U.S. Patent 9,628,269, issued April 18, 2017.

[2] Choi, Jun-won, Joo-Mun Lee, Se-hyun Oh, Myung-Sung Lee, and Whan-Chul Kim. "Authentication and payment system and method using mobile communication terminal." U.S. Patent 9,990,622, issued June 5, 2018.

[3] Daley, Robert S., Pooja Aggarwal, Dilip Krishnaswamy, and Patrik Lundqvist. "Method and system for delivery of targeted information based on a user profile in a mobile communication device." U.S. Patent 9,596,317, issued March 14, 2017.

[4] Stojanovski, Saso, and Arnaud Vedrine. "Mobile terminated communication method and related devices." U.S. Patent 9,906,947, issued February 27, 2018.

[5] Shaju, Chakkalamattam Johnny. "Method and system for tracking mobile communication device using MMS." U.S. Patent 9,729,696, issued August 8, 2017.

[6] Feng, Chang, Asher Shiratzky, and Eyal Elyashiv. "System and method for video communication on mobile devices." U.S. Patent 9,615,056, issued April 4, 2017.

[7] Skouby, Knud Erik, Lene Sorensen, and Samant Khajuria."Introduction to the Minitrack on Privacy, 5G and Economics." (2018).

[8] Katopis, George A. "Operating frequency trends for high performance off-chip buses." In Electrical Performance of Electronic Packaging, 1999, pp. 37-41. IEEE,

[9] Bhaskar, Debasish, Safal Sharma, Rabindranath Bera, Ganesh Sharma, Preman Chettri, and Kharka Bahadur Rai. "Introducing 5G Front -End Femtocell to Improve 4G Network Performance." In Advances in Communication, Devices and Networking, pp. 591 -598. Springer, Singapore, 2018.

[10] World Health Assembly. Resolution WHA51.7. Health for all policy for the twenty-first century. Geneva: World Health Organization, 1998.

[11] 2019, ”Welfare e salute in Toscana”. http://www.regione.toscana.it/documents/10180/13809783/Welfare+e +Salute+2019+vol+1/80c78777-e16e-4f22-ab43-bc9003bb095c last access January 15 2019.

[12] Sarkar U., Gourley G. I., Lyles C. R., Tieu L., Clarity C.,Newmark L.,Singh K., Bates D.W. , 2016, “Usability of commercially available mobile applications for diverse patients”, Journal of General Internal Medicine, 31(12), 1417–1426.

[13] Birkhoff S., Moriarty H., 2016, “Interventions using smartphone health apps across various populations: An integrative review of the literature”, Journal of Informatics Nursing,1(1), 13–24.

[14] Dogac, Asuman, M. Ezbiderli, Yusuf Tambag, C. Icdem, Arif Tumer, Nesime Tatbul, N. Hamali, and Catriel Beeri. "The MARIFlow Workflow Management System." (2001).

[15] Zhang, Yanhua, Xingming Sun, and Baowei Wang. "Efficient algorithm for k-barrier coverage based on integer linear programming." China Communications 13, no. 7 (2016): 16-

[16] Jiang, Li, Hui Tian, Zi Xing, Kun Wang, Ke Zhang, Sabita Maharjan, Stein Gjessing, and Yan Zhang. "Social-awareenergy harvesting device- to-device communications in 5G networks." IEEE Wireless Communications 23, no. 4 (2016): 20 -27.

[17] Alsharif, Mohammed H., and Rosdiadee Nordin. "Evolution towards fifth generation (5G) wireless networks: Current trends and challenges in the deployment of millimetre wave, massive MIMO, and small cells." Telecommunication Systems 64, no. 4 (2017): 617 -637.

[18] Zeng, Jie, Tiejun Lv, Ren Ping Liu, Xin Su, Mingyao Peng, Chang Wang, and Jia jia Mei. "Investigation on Evolving Single-Carrier NOMA Into Multi-Carrier NOMA in 5G." IEEE Access 6 (2018): 48268-48288.

[19] Larsen, Line MP, Aleksandra Checko, and Henrik L. Christiansen. "A survey of the functional splits proposed for 5G mobile cross haul networks." IEEE Communications Surveys & Tutorials (2018).

[20] Backhaul Links Redesign: 5G is expected to redesign the backline hauls to expand its capacity for user traffic generated while simultaneously developing on the radio access networks (RAN).

[21]K. Richardson, “UMTS Overview,” *Electronics & Communication En- gineering Journal*, vol. 12, no. 3, pp. 93–100, 2000.

[22] S. Oulaourf, A. Haidine, A. Aqqal, and H. Ouahmane, “Review on Radio Resource Allocation Optimization in LTE/LTE-advanced Using Game Theory,” *International Journal of Communication Networks and Information Security (IJCNIS)*, vol. 9, no. 1, pp. 117–153, 2017.

[23] M. H. Dahri, M. H. Jamaluddin, M. I. Abbasi, and M. R. Kamarudin, “A Review of Wideband Reflectarray Antennas for 5G Communication Systems,” *IEEE Access*, vol. 5, pp. 17 803–17 815, 2017.

[24] Latif, Siddique, Junaid Qadir, Shahzad Farooq, and Muhammad Ali Imran. "How 5g wireless (and concomitant technologies) will revolutionize healthcare?." Future Internet 9, no. 4 (2017): 93.16.http://www.bristol.ac.uk/engineering/people/264241/pub/164453824

[25] Li, Shancang, Li Da Xu, and Shanshan Zhao. "5Ginternet of things: A survey." Journal of Industrial Information Integration (2018).

[26] Mucchi, S. Jayousi, A. Martinelli, S. Caputo and P. Marcocci, "An Overview of Security Threats, Solutions and Challenges in WBANs for Healthcare," 2019 13th International Symposium on Medical Information and Communication Technology (ISMICT), Oslo,Norway, 2019, pp. 1-6. doi: 10.1109/ISMICT.2019.8743798

[27] L. Mucchi, A. Martinelli, S. Jayousi, S. Caputo and M. Pierobon, "Secrecy Capacity and Secure Distance for Diffusion-Based Molecular Communication Systems," in IEEE Access, vol. 7, pp. 110687-110697, 2019. doi: 10.1109/ACCESS.2019.2932567

[28] 6G technology- opportunities and challenges.