The Implication of Artificial Intelligence in Fifth Generation Network Implementation

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Key words: Artificial intelligence, 5G, Internet of Thing, network management

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Page No.: 77-84
Volume: 20, Issue 3, 2021
ISSN: 1682-3915
Asian Journal of Information Technology

Abstract: The potent combination of 5G, artificial intelligence, smart platforms and the Internet of Things will change the world. Emerging technologies are often portrayed as the 'next big thing' long before they're able to prove it. A fully operative and efficient 5G network cannot be complete without the inclusion of Artificial Intelligence (AI) routines. Existing 4G networks with all IP (Internet Protocol) broadband connectivity are based on a reactive conception, leading to a poorly efficiency of the spectrum. AI and its subcategories like machine learning and deep learning have been evolving as a discipline, to the point that nowadays this mechanism allows fifth-Generation (5G) wireless networks to be predictive and proactive which is essential in making the 5G vision conceivable. These are done through AI-based solution approaches.

INTRODUCTION

The use of AI for network operation and management is known to have great possible to enhance the network performance and efficiency, therefore has received significant interest in both research and industry standardization groups. Prominent industry standard groups, such as ETSI ISG ENI and ZSM and 3GPP SA2 and SA5, have made great efforts to build industry consensus on network architecture and interfaces to enable the use of AI in the network. However, the standardization on AI in network management and orchestration is just at its beginning. Open questions on AI for network management need joint efforts from different standardization groups as well as between the research and industry standardization groups.

5G makes the debate around AI edge computing irrelevant. Imagine the speed in gigabits that 5G can deliver in terms of bandwidth, millisecond latencies and reliable connections. The network architecture easily supports AI processing and will change the AI landscape. To provide some context, it is important to recognize how 5G and AI are embedded together. 5G is described as the next-generation mobile communication tech of the near future and will enhance the speed and integration of various other technologies. This will be driven by speed, quality of service, reliability and so much more that it can do to transform the current way we use the internet and its related services. On the other end, we need to understand that AI is poised to allow machines and systems to function with intelligence levels similar to that of humans. With 5G helping in the background online simulations for analysis, reasoning, data fitting, clustering and optimizations, AI will become more reliable and accessible at the speed of light. Imagine that once you have trained your systems to perform certain tasks, performing analysis will become automatic and faster while costing far less. Put simply, 5G speeds up the services that you may have on the cloud, an effect similar to being local to the service. AI gets to analyze the same

data faster and can learn faster to be able to develop according to users' needs. 5G also promises significant breakthroughs in traditional mobile communications systems. 5G is going to enhance the capabilities of our traditional networks. Even the speed we get over wire or fiber goes much further over a 5G network and evolves to support the applications of IoT in various fields, including business, manufacturing, healthcare and transportation. 5G will serve as the basic technology for future IoT technologies that connect and operate entire organizations, the aim being to support differentiated applications with a uniform technical framework. However, with rapid development, AI is rising to these challenges as it becomes a promising potential support to the problems associated with the 5G era and will lead to revolutionary concepts and capabilities in communications. This will also "up" the game in the applications world as business requirements become more prevalent. As mentioned, the narrowing gap between cloud and on-device processing will be foregone. The reinforcing of the massive IoT network dream will become more feasible[1].

In reality, 5G will take some time to have significant impact on AI processing. In the meantime, as AI applications are being integrated into devices, rather than waiting for 5G to be deployed, there seems to be a safe strategy to rely on device-based processing of AI. However, one thing is for sure: the push is to have 5G and AI integration happen on the same chips on your mobile smart phones, making those phones more intelligent as well. The question now is we ready to see this happen? Well, it already is beginning to unfold in some countries around the world with China leading the pack. The smart phone arena seems to be especially competitive which can force earlier adoption and change of networks. Be ready, from the security to assurance lanes as we will need to re-adapt ourselves to those very standards sooner than later.

The evolution of mobile networks is hitting an entirely new level with the advent of 5G. It is more than just a faster, better network built to handle more users, more data and more services. In fact, 5G will require networking on a whole new level! After all this will be the first network designed to support non-telecommunications services, bridging wireless and wire line technologies and providing new ways to support human and machine interactions. 5G demands we change the way we set up and provision networks and manage network traffic. Static networks will be a thing of the past, as flexible and dynamic networks are needed to manage the fluctuations of a 5G world. The number of factors affecting the network will be endless. And the ability of humans to process and then act upon all this information in real time, or at any time, will be impossible. To support 5G, networks will need to be optimized for new paradigms of service delivery, effectively requiring artificially intelligent, multi-gear networks to deliver truly cognitive networks[2].

Background information: The powerful combination of 5G, artificial intelligence, smart platforms and the Internet of Things will change the world. Drawing on interviews with mobile operators, investors and analysts, this report describes some of the exciting services and experiences that could be enabled by intelligent connectivity[3].

Entertainment gets rich and social: With 5G, digital entertainment is set become both richer and more social. High-speed wireless connectivity will deliver 4K and 8K video, holograms, augmented reality and virtual reality applications for gaming and immersive TV while bringing people together to enjoy live events such as sports and concerts. 5G could enable spectators to enjoy a 360° view from anywhere in the venue.

Safe and swift transportation: Vehicles and bikes will relay their position to other road users in real-time, enabling intelligent connectivity to instruct vehicles when to slow down and when to accelerate, thereby removing the need for traffic lights, speed cameras and other systems.

The dawn of industry 4.0: Intelligent connectivity is set to drive a fourth industrial revolution in which computers and robots continually optimize production and maintenance in highly flexible factories and plants. 5G will deliver ultra-reliable and low latency connectivity by employing edge computing and network slicing which allows specific services to be prioritized.

Reliable remote control: In both their personal and professional lives, individuals are going to have much closer control over their assets. Tactile Internet applications will become increasingly viable, allowing for the perception and manipulation of remote objects using touch and proprioception.

Information and offers on-demand: People will have easy access to an increasingly intelligent personal assistant in the cloud while connected glasses or contact lenses will display personalized information and offers.

Continuous health monitoring: Individuals will routinely wear connected wellness and security monitors providing continuous information about their vital signs, while enabling emergency alerts in the event of a fall or an attack. 5G will help healthcare managers to maximize the use of scarce resources and ensure that clinics don't run out of critical medicines and equipment. Applying AI applications to 5G for the purposes of streamlining and

customizing services and increasing a provider's Return on Investment (ROI) is no longer a futuristic fantasy but a quickly evolving reality.

Smarter and sharper security: Continuously connected cameras, sensors and alarms will make both private properties and public places more secure while cloud-based facial recognition systems could be used identify and spot offenders in real time.

Immersive education and training: Trainee engineers, mechanics and medics could learn how to perform specific tasks by following instructions relayed via AR or by using VR simulations. Similarly, 5G could enable these technologies to be used to teach science and geography students about specific habitats and environments.

Waste, not, want not: Consumers and companies will have real-time information on everything from soil acidity to water pollution to the availability of parking spaces, increasing efficiency and reducing waste while better managing energy usage.

Smarter cities and buildings: Connected sensors and actuators will give municipalities, organizations and individual citizens the ability to monitor what is happening in and around their properties and control access.

All around the world, service providers are in the midst of moving 5G forward through planning, trials and operations[4]. But the fluctuating complexities of this exciting 5G revolution have sometimes presented a barrier to obtaining actionable, reliable data. Our latest report helps to change that, by providing service providers with critical information about using AI with 5G including business and operational challenges, benefits and opportunities. For C-suite decision makers and anyone with an interest in developing AI techniques to enhance 5G planning, trials and deployment, the latest findings offer critical and timely insight[5]. The impetus for the latest report comes from an increasing need for relevant, up-to-date data about how service providers view and integrate AI in to their networks as they embark on their 5G journey. And this report provides exactly that, based on a global comparison of high-level business objectives[6]. Mapping the response of >160 executives from well over a hundred operators across the globe, the report provides valuable insights both broad and specific about the reasoning and expectations of service providers in using AI (machine learning) applications across 5G networks. In some instances, the findings may even surprise to the point that they could impact or alter current business decisions[7]. Given the senior management nature of the participants, from CTOs to CFOs, the report's underlying data is considered highly representative of current service provider thinking. Consequently, it can serve as a near real-time road map as to the current confluence of AI and 5G and where it's heading. For instance, more than half of operators across the globe expect to adopt AI in their networks by the end of 2020[8].

5G gives an AI-enabled IoT the speed it needs: Like AI, 5G infrastructure opens up a new breed of previously-impossible applications within the IoT. But while AI enables insight from mass data, these applications will rely on 5G's super-fast bandwidth, virtually zero latency and rock-solid reliability to provide access to that data[9]. We saw the seeds of that at Mobile World Congress 2019 with live-streamed sports games allowing event delegates to choose from >100 camera angles with instant switching. The upgrade in network data capacity required for this sort of widely-deployed service dwarfs what previous generation networks could deal with. Beyond entertainment, we'll see all sorts of businesses taking advantage of the super-responsiveness of 5G networks in combination with other fifth wave of computing technologies. Applications requiring huge payloads of data to be transmitted and processed in milliseconds and with a high degree of reliability will become possible.

A sustainable, data-rich future: In its entirety, the Fifth Wave of Computing stretches our imagination. On-tap access to intelligent, data-driven insight will not only drive efficiencies in industry but those efficiencies necessary to cope with the next century's societal challenges, too. We founded the 2030 Vision, a cross-sector collaboration designed to foster innovation that supports the UN Global Goals, for this very purpose. It's my hope that the Fifth Wave of Computing plays a fundamental role in realizing this vision making cities, healthcare, transportation, manufacturing and agriculture smarter, more efficient and more sustainable[10].

Until that time, we must explore the links between the core technologies AI, 5G and the IoT and work out how they can be mutually supportive. We must also think carefully about the infrastructure the fifth wave of computing needs so there's a solid base for future growth. Non-negotiable in building that infrastructure must be flexibility, security, privacy and efficiency. So, while we may not be standing at full height on our fifth wave surfboard yet, we're already seeing what a combination of AI, secure IoT and 5G can bring. An exciting future waits[11].

ML and AI for beam forming: 5G, deployed using mm-wave has beam-based cell coverage unlike 4G which has sector-based coverage. A machine learned algorithm

can assist the 5G cell site to compute a set of candidate beams, originating either from the serving or its neighboring cell site. An ideal set is the set that contains fewer beams and has a high probability of containing the best beam. The best beam is the beam with highest signal strength a.k.a. RSRP. The more activated beams present, the higher the probability of finding the best beam; although the higher number of activated beams increases the system resource consumption.

The User Equipment (UE) measures and reports all the candidate beams to the serving cell site which will then decide if the UE needs to be handed over to a neighboring cell site and to which candidate beam. The UE reports the Beam State Information (BSI) based on measurements of Beam Reference Signal (BRS) comprising of parameters such as Beam Index (BI) and Beam Reference Signal Received Power (BRSRP). Finding the best beam by u sing BRSRP can lead to Multi-Target Regression (MRT) problem while finding the best beam by using BI can lead to Multi-Class Classification (MCC) problem.

ML and AI can assist in finding the best beam by considering the instantaneous values updated at each UE measurement of the parameters mentioned below[2]:

- Beam Index (BI)
- Beam Reference Signal Received Power (BRSRP)
- Distance (of UE to serving cell site)
- Position (GPS location of UE)
- Speed (UE mobility)
- Channel Quality Indicator (CQI)
- Historic values based on past events and measurements including previous serving beam information, time spent on each serving beam and distance trends

Benefits of leveraging ML and AI in 5G: The application of ML and AI in wireless is still at its infancy and will gradually mature in the coming years for creating smarter wireless networks. The network topology, design and propagation models along with user's mobility and usage patterns in 5G will be complex. ML and AI can will play a key role in assisting wireless operators to deploy, operate and manage the 5G networks with proliferation of IoT devices[12]. ML and AI will build more intelligence in 5G systems and allow for a shift from managing networks to managing services. ML and AI can be used to address several use cases to help wireless operators transition from a human management model to self-driven automatic management transforming the network operations and maintenance processes.

There are high synergies between ML, AI and 5G. All of them address low latency use cases where the sensing and processing of data is time sensitive. These use cases include self-driving autonomous vehicles, time critical industry automation and remote healthcare. 5G offers ultra-reliable low latency which is 10 times faster than 4G. However, to achieve even lower latencies, to enable event-driven analysis, real-time processing and decision making, there is a need for a paradigm shift from the current centralized and virtualized cloud-based AI towards a distributed AI architecture where the decision-making intelligence is closer to the edge of 5G networks[12].

Machine learning in 5G planning and deployment: 5G is a change of concept in mobile services; this new concept will assume new frequencies to provide different kinds of services routing communications based on the speed needed for the servicelooking to obtain the maximum performance combining coverage, propagation and the penetration bandwidth compatible with the kind of service to be used. This service will combine different techniques such as frequency allocation, carrier aggregation or MIMO (multiple in multiple out) as an example. The knowledge obtained from 4G analysis performs the basis for the 5G model. To design the new model the definition of segmented models is highly significant where we will testthe obtained predictive functions, testing the needs of coverage and based on service areas and demand of services. Once the type of demand of service can be managed by changing the variable values, we will introduce new frequencies and services looking for the reinforcement of services in the mapped areas where the model shows there is a lack of services. The definition of this new model gives us the opportunity of introducing two new learning algorithm types, such as reinforcement learning. This introduces feedback to correct and learn the ways tooptimize selected variables and to multitask the learning of algorithms using homologous theory where the system learns over other solutions obtained in the past based on similar conditions[13]. Once this kind of model has been developed, we could develop Bayesian networks to predict the mostprobable behavior of the designed network. Network deployment using this tool will allow the measuring of the values predicted for the system and the values obtained will be used to provide feedback to the systems providing new entrances to validate the model and reinforce the learning capabilities of the system based in machine learning. It is very important to define the scenario of where we are working, starting with the definition of the components of the system identifying the variables with incidence in the work with the functions that predict the behavior of these variables. All these variables with an undefined standard set of values or logical status will be played using Montecarlo models, Markov chains or other statistical sources, based in the universe of the variable and its statistical patterns. The use of described techniques will provide three stages of

learning: "Grow", learning from theenvironment; "Restructuring", learning from corrections and obtaining new knowledge form this action and adjustment generalizing concepts and adjusting from the values obtained from the experience sensing of the real world. 5G will need a great quantity of sites with different frequencies and services. This situation will create a complex and multivariable scenario. Machine learning gives us the tools to define the patterns in this multivariable scenario, showing even those patterns for which we do not know of their existence. This planification, testing adjustment and network deployment, looking for the better balance between power, height of antennas, location and density of the network crossed with the aleatory demand of services in the universe of individual users and types of devices could not be solved without described tools[3].

MATERIALS AND METHODS

Method used: An exploration of the potential of AI-based solution approaches in the context of 5G mobile and wireless communications technology is presented, evaluating the different challenges and open issues for future research are presented[12]. The field of intelligent decision making is expanding rapidly due, in part, to advances in artificial intelligence and network centric environments that can deliver the technology. Communication and coordination between dispersed systems can deliver just-in-time information, real-time processing, collaborative environments and globally up-to-date information to a human decision maker. At the same time, artificial intelligence techniques have demonstrated that they have matured sufficiently to provide computational assistance to humans in practical applications[14].

RESULTS

After exploring some of the successful cases where AI is used as a tool to improve 5G technologies, we strongly believe that the convergence between these two knowledge expertise's will have an enormous impact in the development of future generation networks. The era where wireless networks researchers were afraid to use AI-based algorithms due to the lack of understanding of the artificial-learning process, has been left in the past. Nowadays, with the power and ubiquity of information, numerous researchers are adapting their knowledge and expanding their tools arsenal with AI-based models, algorithms and practices, especially in the 5G world, where even a few milliseconds of latency can make a difference.

The study explores a number of AI opportunities that are being widely considered or pursued by operators. The primary focus among operators is to use AI to improve network capacity management. Other focus areas include reducing network planning time frames and infrastructure modeling to reduce Capital Expenditures (CapEx). Based on the data, however, the benefits of AI is shown to extend beyond cost-management and network-management efficiencies, with one notable addition being the enhancement of the user experience. Also touched on is the drive among providers to build AI reasoning-based systems that can eventually introduce the self-healing, self-optimizing and self-configuring networks of tomorrow. Across the board, the report captures a strong correlation between increased reliance on smart automation enabled by AI and significant returns on investments realized principally through reduced operating costs[15]. The impact of 5G will be readily noticeable to consumers and businesses that use applications that depend on IoT connected devices. Faster machine-to-machine communications, for example, will enable ubiquitous streaming video feeds to managers who can use them for previously impossible analyses. Likewise, 5G will allow smart medical equipment to quickly analyze mass amounts of patient data from multiple sources. Consumers will benefit from enhanced entertainment options that will come with the 5G revolution. Virtual Reality (VR) headsets, for instance, will become even more realistic as data processing limits increase and edge computing helps to reduce latency and lag times for streaming entertainment. The business use cases for 5G will range from enhanced logistics more fuel-efficient self-driving trucks, for example to more robust video conferencing connectivity. Businesses and consumers will also benefit from the next iteration of 5G-enabled smart cities. For example, machine-to-machine communications will help automatically optimize electricity usage, better coordinate streetlights and improve traffic flow.

Advanced manufacturing is a key example in which 5G has the potential to improve operations and productivity. Thanks to AI, machine learning and the IoT, autonomous machines will be able to self-diagnose problems, reduce errors and increase output. Clearly, if 5G networks are going to be as per formant and responsive as operators envision and at a cost that's not exorbitant machine intelligence will have to do much of the heavy lifting. But not all AI is created equal. Even the best machine learning algorithm is still just an algorithm. Its effectiveness in achieving a desired outcome depends on other factors: the quality of the data it's training on and the domain expertise of the people guiding that training. When evaluating 5G tools, operators should look for those with access to the most diverse and highest-quality data. For example, you may have an excellent tool for analyzing drive-test data or geo-data in 3G and 4G networks. But, if that tool only works with a few narrow

data sources, it's only looking at one piece of the puzzle. More effective 5G machine intelligences will pull from all those sources simultaneously as well as planning data, device-based measurements and other real-time and historical data sources, to capture a holistic view. Of course, it's not just the number of data sources you feed your AI. Effective machine intelligence needs to know which data is actually meaningful across that ocean of information and how to effectively prioritize and act on it. The training models an AI uses make all the difference and the quality of those models depends directly on the domain expertise of the people developing them[16].

5G networks really will deliver outstanding new experiences and AI will play a key role in making it happen. But just because a given tool uses machine learning doesn't mean it's using it effectively. Recognizing the importance of machine intelligence to so many areas of 5G, operators should look for solutions with broader, more holistic data capabilities whenever possible. They should seek out tools that analyze data from the most diverse sources and that are designed by organizations with broad and deep experience in mobile networks and RF performance. Last but not least, operators need 5G testing tools that enable machine learning techniques to detect and evaluate in real time the performance of the AI embedded in the network which is expected to be network vendor specific and based only on high-level guidance from 3GPP. With the right data and models, AI can help operators achieve unprecedented levels of performance and automation in their 5G networks. For the companies that do it right, AI-fueled insights and capabilities will translate to higher QoE, lower costs, reduced risk and a significant competitive edge[17].

DISCUSSION

Artificial Intelligence (AI) holds tremendous promise for so many applications but processing speed has been a limiting factor against more widespread proliferation. With the advent of 5G wireless technologies, this processing limitation may be less of a factor going forward. To provide some context, it is important to recognize how 5G and AI are embedded together. 5G is described as the next-generation mobile communication tech of the near future and will enhance the speed and integration of various other technologies. It will be driven by speed, quality of service, reliability and so much more to transform the current way we use the internet and its related services. On the other end, we need to understand that AI is poised to allow machines and systems to function with intelligence levels similar to that of humans. With 5G helping in the background online simulations for analysis, reasoning, data fitting, clustering and optimizations, AI will become more reliable and accessible at the speed of light. Imagine that once you have trained your systems to perform certain tasks, performing analysis will become automatic and faster while costing far less. On a global level, we need to understand that 5G stands at the crossroads of speed that will change the processing capabilities for AI and will narrow the gap between processing in the cloud versus on devices. Put simply, 5G speeds up the services that you may have on the cloud, an effect similar to being local to the service. AI gets to analyze the same data faster as well as to learn faster to be able to develop according to users' needs. It also is going to be a major contributor to driving centralized processing. 5G makes the debate around AI edge computing irrelevant. Imagine the speed in gigabits that 5G can deliver in terms of bandwidth, millisecond latencies and reliable connections. The network architecture easily supports AI processing and will change the AI landscape. 5G also promises significant breakthroughs in traditional mobile communications systems. It is going to enhance the capabilities of our traditional networks. Even the speed we get over wire or fiber goes much further over a 5G network and evolves to support the applications of IoT in various fields including business, manufacturing, healthcare and transportation. 5G will serve as the basic technology for future IoT technologies that connect and operate entire organizations, aiming to support differentiated applications with a uniform technical framework. This will also 'up' the game in the applications world as business requirements become more prevalent. As mentioned, the narrowing gap between cloud and on-device processing will be foregone. The reinforcing of the massive IoT network dream will become more feasible. In reality, 5G will take some time to have significant impact on AI processing. In the meantime, as AI applications are being integrated into devices, rather than waiting for 5G to be deployed, there seems to be a safe strategy to rely on device-based processing of AI. However, one thing is for sure: the push is to have 5G and AI integration happen on the same chips on your mobile smart phones, making those phones more intelligent as well. 5G cellular networks are assumed to be the key enabler and infrastructure provider in the ICT industry, by offering a variety of services with diverse requirements. The standardization of 5G cellular networks is being expedited which also implies more of the candidate technologies will be adopted. Therefore, it is worthwhile to provide insight into the candidate techniques as a whole and examine the design philosophy behind them. In this study, we try to highlight one of the most fundamental features among the revolutionary techniques in the 5G era, i.e., there emerges initial intelligence in nearly every important aspect of cellular networks, including radio resource management, mobility management, service provisioning management and so on. However, faced with

ever-increasingly complicated configuration issues and blossoming new service requirements, it is still insufficient for 5G cellular networks if it lacks complete AI functionalities[18]. Hence, we further introduce fundamental concepts in AI and discuss the relationship between AI and the candidate techniques in 5G cellular networks. Specifically, we highlight the opportunities and challenges to exploit AI to achieve intelligent 5G networks and demonstrate the effectiveness of AI to manage and orchestrate cellular network resources. We envision that AI-empowered 5G cellular networks will make the acclaimed ICT enabler a reality.

5G and Beyond 5G (B5G) networks will support a variety of services and verticals (enhanced mobile broadband, health, industry 4.0, smart energy and automotive). These services, verticals and the critical components that compose 5G architecture (e.g., radio access, edge and core networks) face new cyber security risks and challenges.

CONCLUSION

The study Generalize that fully operative and efficient 5G network cannot be complete without the inclusion of Artificial Intelligence (AI) routines. Existing 4G networks with all-IP (Internet Protocol) broadband connectivity are based on a reactive conception, leading to a poorly efficiency of the spectrum[19]. The amount of data is increasing rapidly. More and more devices can produce and transmit data. We live in a world that threatens to drown in the flood of data. The merger of 5G, IoT and AI could help us and be of great importance when it comes to profiting from the rapid increase in available data. Ultimately, the Fifth Wave of Computing will revolutionize how we use data. The IoT will gather it more abundantly, AI will process it more intelligently and 5G will distribute it faster and with higher capacity. When the Fifth Wave of Computing reaches full maturity, it will drive learning and AI inference everywhere. But while AI, the IoT and 5G are still emergent technologies, we don't have to wait for them to fully mature before we reap the benefits. Arm is partnering with technology pioneers all over the world who see the potential in the fifth wave of computing and are making first moves[16].

5G also promises significant breakthroughs in traditional mobile communications systems. It is going to enhance the capabilities of our traditional networks. Even the speed we get over wire or fiber goes much further over a 5G network and evolves to support the applications of IoT in various fields, including business, manufacturing, healthcare and transportation. 5G will serve as the basic technology for future IoT technologies that connect and operate entire organizations, aiming to support differentiated applications with a uniform technical framework. 5G networks represent a breakthrough in the design of communication networks, for their ability to provide a single platform enabling a variety of different services, from enhanced mobile broadband communications to virtual reality, automated driving, Internet-of-Things, etc. Nevertheless, looking at the increasing requests for new services and predicting the development of new technologies within decade from now, it is already possible to envision the need to move beyond 5G and design a new architecture incorporating new technologies to satisfy new needs at both individual and societal level. The goal of this research is to motivate the need to move to a sixth Generation (6G) of mobile communication networks, starting from a gap analysis of 5G and predicting a new synthesis of near-future services, like holographic communications, high precision manufacturing, a pervasive introduction of artificial intelligence and the incorporation of new technologies, like sub-THz or Visible Light Communications (VLC), in a truly 3-Dimensional (3D) coverage framework, incorporating terrestrial and aerial radio access points to bring cloud functionalities where and when needed on demand. 5G cellular networks are assumed to be the key enabler and infrastructure provider in the ICT industry, by offering a variety of services with diverse requirements. The standardization of 5G cellular networks is being expedited which also implies more of the candidate technologies will be adopted. Therefore, it is worthwhile to provide insight into the candidate techniques as a whole and examine the design philosophy behind them[20].

REFERENCES

01. Anonymous, 2019. Technical specification: Cyber security for consumer internet of things. ETSI TS 103 645 V1.1.1, ETSI, Sophia Antipolis, France.
02. Li, R., Z. Zhao, X. Zhou, G. Ding, Y. Chen, Z. Wang and H. Zhang, 2017. Intelligent 5G: When cellular networks meet artificial intelligence. IEEE. Wireless Commun., 24: 175-183.
03. Anonymous, 2019. New GSMA report highlights global role of intelligent connectivity. GSM Association, London, UK.
04. Borcoci, E., 2019. Cognitive technologies in 5G slicing management and control. Proceedings of the InfoWare 2019 Conference, June 30-July 4, 2019, IARIA, Rome, Italy, pp: 1-113.
05. Anonymous, 2019. AI and big data analytics in telecoms, 2019 Report: Telco use cases and monetization strategies. GlobeNewswire, Inc. Los Angeles, California.
06. Anonymous, 2019. Employing AI to enhance returns on 5G network investments. Cambridge innovation Institute, Needham, Massachusetts.

07. Latva-Aho, M. and K. Leppanen, 2019. Key drivers and research challenges for 6G ubiquitous wireless intelligence. 6G Flagship, University of Oulu, Oulu, Finland.
08. Fersman, E., 2018. Machine intelligence for telecom and beyond. Ericsson Telecommunications Company, Kista, Stockholm.
09. NTT Docomo, 2018. Ntt docomo: Integrated reports (annual reports). NTT DoCoMo, Tokyo, Japan.
10. Anonymous, 2019. 5G and the fourth industrial revolution. The Institute of Internal Auditors, Lake Mary, Florida.
11. Zhao, H., C. Lee and J. Song, 2018. The impact of artificial intelligence on communication networks. ITU J. ICT: Discoveries, Vol. 1, No. 1.
12. Cayamcela, M.E.M. and W. Lim, 2018. Artificial intelligence in 5G technology: A survey. Proceedings of the 2018 International Conference on Information and Communication Technology Convergence (ICTC), October 17-19, 2018, IEEE, Jeju, South Korea, pp: 860-865.
13. Schneider, B.Y.W., 2019. Dominance of the global. Infosphere, USA.
14. Seger, J. and S. Mueller, 2019. The AIGO: A framework for planning, developing and deploying artificial intelligence in intergovernmental organizations. The Future of Security Inc., Toulouse, France.
15. Anonymous, 2018. Huawei intent-driven network white paper. Huawei Technologies Co., Ltd., Shenzhen, China.
16. Yao, M., M. Sohul, V. Marojevic and J.H. Reed, 2019. Artificial intelligence defined 5G radio access networks. IEEE Commun. Mag., 57: 14-20.
17. Gartner, 2019. 5G: The future of IoT. 5G American white Paper, Gartner IT Service Management Company, Stamford, Connecticut.
18. Anonymous, 2019. Five converging forces that are driving technological evolution. Cyber Media India, India.
19. Waterfront, V. and P. Wharf, 2019. 5G demand and future business models towards a feasible 5G deployment. Valletta Waterfront, Floriana, Malta.
20. Anonymous, 2019. Technology, media and telecommunications predictions 2019. Deloitte Development LLC., Nashville, Tennessee.