5G Technology Salient features and Architecture: An Overview

Fadhil T Alawe
University of Thi Qar
Email:fta2015@gmail.com

Abstract

5G is a 5th Generation technology breakthrough in the telecom networks continue to expand worldwide. It is unleashed into the world telecom technology market, greatly support the massive IoT ecosystem to connect billions of IoT application devices with apt trade-offs between speed, latency and cost. The paper is presenting the salient features of 5G Networks, Architecture, Implementation, Advantages, Disadvantages. The paper is presenting a special focus on the management of 5G in different segments, different algorithms used with 5G in association with suitable examples.

Key words: 5G Networks, Network management, sensing, mining, prediction, reasoning.

Introduction

5G networks are introduced to enable a great infrastructure in the Information Communication Technology industry with great deal of services to various prominent segments. The design philosophy behind 5G is enriched with candidate technologies. It is a next generation cellular network with extended features never before provided in the wireless sensor networks. It is developed with revolutionary techniques to provide highly economical energy usage, 100 times better connectivity with the devices per unit area, lowest latency and unbelievable bandwidth per unit area up to 10Gbps data rate. It is demonstrating the superfast speed and highest quality with the help of shorter frequencies such as millimetre waves between 30GHs to 300 GHs [10]. It has been introduced in prominent cities of the world. The has provided the highest download speed ranging from 220 megabytes per second to 950 megabytes per second. It is 50 times better than 4G networks demonstrated. The 5th Generation Networks provided lowest latency rate of 1 millisecond for the delay between sending and receiving the data packets [6].

Salient features of 5G

The salient features of 5G networks are Intelligence, Artificial Intelligence, Smartness, Speed, Latency, Bandwidth [9].

Intelligence: 5G networks are enriched with diverse configurations to provide multiple pre-defined options and respond to the environment. 5G networks can allow granted and grant free transmission while it is catering enhanced Mobile Broad Band and massive Machine Type Communication services and Ultra reliable and low latency communications with automatic adjustment by detecting various pre-defined service indicators.

This can be done by the power of Radio Resource Management Techniques. The intelligence is adopted by candidate technology which is the back bone for 5G. Using this technology 5G can make appropriate responses for strange scenarios with different tasks [10].

Smartness 5G networks are regarded as smart networks. 5G is predominantly used in the operations of smart cities in association with IoT applications. It is an integral part of smart grid electrical power transmission, control and distribution systems. The smartness of 5G infrastructure can be demonstrated in association with Alliance for Internet of Things Innovation Association. Smart signature is one of the features of 5G networks. The devices are facilitating the subscribers to do more by providing required data allocation according to the applications usage up to 30GB per month [7].

Artificial Intelligence is an integral part of 5G networks to provide the services on part with a human expert for the complexity tasks of IT networks. Offloading with latency and energy efficiency based on the mobile edge computing devices predominantly using with IoT applications connected to the MEC cloud servers. To facilitate the smart networks by 5G machine learning and Artificial Intelligence algorithms are used to analyse multidimensional data [3].

Speed is another predominant feature of 5G networks. The enormous speed up to 10 Gigabits per second can be enjoyed in 5G networks. Where as the present speed of 4G is limited to 100 Megabits per second. 5G is 100 times faster than 4G networks [4].

Latency of 5G networks has modified with the intervention of Mobile Edge Computing. Due to this technology the processing can be performed closer to the user. It eliminates the need of sending the data to cloud and back. Hence the latency has been recorded with 1 millisecond in the transmission [10].

Bandwidth of 5G networks are unmatchingly big ever seen in the world. It can provide the bandwidth up to 10Gegabits per second. It is also providing this bandwidth with low power consumption. These features are predominantly solicited by the mobile internet of Things and critical communication segments [11].

Related work

5G Mobile communication system is predominantly catering the needs of the next generation applications to match with the technology paradigms. It is enriched with the service provision management feature to support the multi and complex computational tasks offloading in mobile edge computing associated with the IoT applications configured with billions of mobile devices [12].

The next generation mobile communication system 5G is developed with five predominant layers mechanism to support all the applications. It is incorporated with the concepts of Artificial Intelligence to play a predominant service provisioning mechanism. This has given rise to the capability to perform more than 2000 parameters [12].

The smart cellular network 5G is developed to demonstrate the global control features with its Artificial Intelligence center to support service awareness, traffic prediction and requirement cognition. The global control ensures the routing, caching, safety, power control, scheduling and user association. AI enriched Global Control is working with RAN controller and CN Controller to perform reasoning, sensing, Mining and predicting [3].

Architecture

The system model of 5G networks is developed on the basis of IP based model. The system is configured with a main user terminal and it can be connected to numerous independent and autonomous radio access technologies. It is built on the intelligent architecture with Radio Access Networks no longer constrained by base station proximity. Through this architecture 5G can provide flexible, virtual and disaggregated additional data access points. The important layers of 5G networks are network layer, controller layer, management layer, orchestration layer and service layer.

5 G networks Management

5G wireless networks is equipped with Radio Resource Management. It adopted non-orthogonal multiple access schemes like sparse coding multiple access. The Radio Resource Management is used for successive interface cancellation receivers to decode the received information. This feature gives raise to the efficiency of the granted transmission and grant-free transmission in Uplink [9].

5G wireless mobile networks are enriched with mobility management to provide much greater spectrum awarding at untapped millimeter wave frequency bands. Mobile management in 5G enhances the batter life, lower outage probability, high volume bit rate in larger portion of the coverage areas. It can perform with lower infrastructure cost and higher aggregate capacity for various simultaneous used in licensed spectrum and unlicensed spectrum. Because of this feature 5G networks technology enables to attain the speed greater than 100 Mbps at full mobility and higher than 1 Gbps at low mobility [12].

5G cellular networks are strengthen with maturity of software-defined networks. Management and orchestration is at good level to provide the virtualization of existing hardware devices like customer premises equipment, Optical line transmission and Broadband network gateway. 5G mobile sensor networks supports the open network operating system on commodity hardware and software elements. It is supported by the Central Office Re-architected as a Data Center with a provision of framework to plugged with software elements. 5G wireless communications are software -defined radio access and core infrastructure to support various software applications [5].
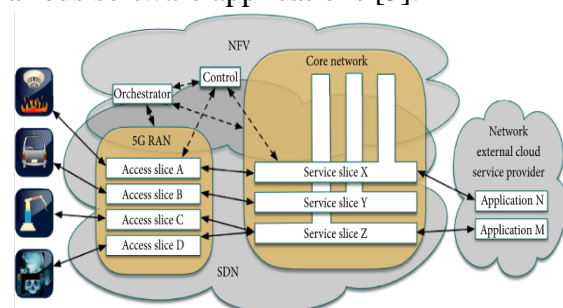

Figure 15G radio access and core networks architecture to support software applications

Service Provisioning Management is a profound feature in 5G wireless networks to make it as smart network. Service Provisioning Management enables 5G to perform softer air interface with flexible service provisioning stack. Network Slicing is a profound concept introduced by 5G with the help of network function virtualization. This has given rise to the capability to intelligently create customized network pies to facilitate optimized solutions for various services with diverse functionalities and performance metrics. Session Management enabled 5G to adopt UE attributes and service requirements to perform mobile edge computing offloading the computational tasks [11].

Algorithms

5G mobile wireless sensing networks can be implemented with logistic regression algorithms, support vector machine algorithms, Hidden Markov model algorithms for supporting the sensing modules. Supervised learning can be enhanced with the Gradient boosting decision tree algorithms. Unsupervised learning can be enriched with the help of spectral clustering algorithms and Replicator Neural Networks. The prediction module of 5G networks can be used with the Kalman Filtering algorithms, Auto regressive moving average algorithms and deep learning algorithms. 5G cellular networks can be used with Dynamic programming algorithms, Branch-and-Bound method algorithms, Reinforcement Learning algorithms to enhance the capability of reasoning [11].

The main objective of using these algorithms is to enhance the detection of networks anomalies, classifying services according to the required provisioning, forecasting the trend of UE mobility of the traffic volume and configuration of series of parameters to provide better services to various applications. Apart from the above-mentioned algorithms there are several algorithms can be used to increase the performance of 5G mobile wireless communications [1].

Applications

The next generation 5G wireless networks are helping the applications of various fields which could not be catered by previous networks effectively and efficiently. It is providing the services to various applications with its intelligently programmed Application Programming Interface and network function virtualization [3]. These are namely 1. High speed mobile networks, Entertainment and multimedia everything on cloud, ubiquitous connectivity, intuitive remote access, immersive experience of high quality videos, connecting with billions of mobile devices with cloud MEC servers for IoT applications, Smart home applications, smart and remote management of logistics and shipping, Industrial IoT applications, Smart Forming, Smart and Intelligent Fleet management, Healthcare and mission critical applications, Autonomous Driving applications, remote drone operations, Security and surveillance and many more [15].

Advantages

5G networks are regarded as intelligent wireless networks of next generation communictions [13]. It is facilitating the services to various distinct applications with flexible, intelligent and affordable mode [2].

It can provide end-to-end slicing spanning over domains [1]. It can cater the services to the multiple logical networks related to different operations and verticals [11]. It can support multiple telecommunication services with heterogeneous key performance indicators in most economic pricing [9]. It is supporting remote surgical operations, immersive Virtual Reality Gaming and Simulating translating [7]. It is used for expanded broadband wireless services beyond mobile internet to IoT critical wireless communication sectors. It is providing massive mobile to mobile Internet of Things supporting billions of mobile devices with MEC servers [15]. It is facilitating Ultra low latency Internet of Things critical communications [4].

Disadvantages

5G next generation wireless networks are found with the disadvantages. The range of 5G wireless connectivity is observed to be good in short distance and the frequency is interrupted by physical obstructions like Towers, walls, buildings or trees. This is happened with the high-frequency signals which can be absorbed by the physical blocks [8].

The initial cost involved in the infrastructure development for 5G networks is significantly high. So that the cost will be levied by the end customers. The maintenance cost is also comparatively higher than 4G networks [16]. The usage of 5G wireless networks are limited to urban and metropolitan areas. It is limited to serve in the larger and densed populations [10]. The devices which are connectivity are need to be modified to suite the next generation 5G. otherwise the existing batteries

prevail in the devices are getting drained within short span of time [15].

It is observed that the upload speed is not equal to download speeds. Download speed is remarkably high whereas the upload speed is not at all matching with the speeds [1]. The cell towers used for 5G wireless technology are need to deployed in the places. There is a great rejection from the public to bear the frequencies delivered from the cell towers [16].

Conclusion

The paper' Intelligent 5G wireless communication system' has reviewed the salient features of 5G wireless networks and Architecture. The significant features derived from different management concepts implemented in 5G wireless sensor technology. The features and management concepts presented in this paper has demonstrated the power of 5G in establishing the smart cities and intelligent functionalities replacing the human intervention. The paper presented the list of algorithms and prominent applications used with the aid of 5G networks. The paper has concluded by presenting the advantages and disadvantages of 5G networks as the intelligent and smart networks of 21st century.

Future Scope of study

There is a great deal of future scope for doing the study on the in-depth concepts of the next generation communication system. The future scope of the study should be done on the algorithms which are going to enhance the distinct areas. The present study has enlisted the limited number of algorithms which are

going to enhance the power of 5G networks. The future scope should concentrate on the machine learning algorithms in enhancing the power of Artificial intelligence in association with the Internet of Things with massive number of devices playing vital role in the functioning of the Smart Cities.

References

1] Al-Falahy, Naser & Alani, Omar. (2017). Technologies for 5G Networks: Challenges and Opportunities. IT Professional. 19. 12-20. 10.1109/MITP.2017.9.

2] Bajaj, Anu & Tamanna, & Sangwan, Om. (2019). SMART 5G: Artificial Intelligence Empowered 5G Networks. published in 2nd National Seminar on "Design of 5G Mobile Networks Using Soft Computing Techniques", Guru Jambheshwar University of Science and Technology, Hisar, Haryana.

3] Casillas, Robert & Touchette, Bennett & Tawalbeh, Loai & Muheidat, Fadi. (2020). 5G Technology Architecture: Network Implementation, Challenges and Visibility. International Journal of Computer Science and Information Security, 18. 39-53.

4] Dini, Paolo & Rossi, Michele. (2019). Machine Learning for 5G Mobile Networks: a Pragmatic Essay on Where, How and Why.

5] Gianfranco Nencioni ,Rosario G. Garroppo , Andres J. Gonzalez , Bjarne E. Helvik and Gregorio Procissi (2018) Orchestration and Control in Software-Defined 5G Networks: Research Challenges published by Wireless Communications and Mobile Computing / 2018

6] Javaid, Nadeem & Sher, Arshad & Nasir, Hina & Guizani, Nadra. (2018). Intelligence in IoT-Based 5G Networks: Opportunities and Challenges. IEEE Communications Magazine. 56. 10.1109/MCOM.2018.1800036.

7] Li, Rongpeng & Zhifeng, Zhao & Zhou, Xuan & Ding, Guoru & Chen, Yan & Zhongyao, Wang & Zhang, Honggang. (2017). Intelligent 5G: When Cellular Networks Meet Artificial Intelligence. IEEE Wireless Communications. PP. 2-10. 10.1109/MWC.2017.1600304WC.

8] Noohani, Meer Zafarullah & Magsi, Kaleem Ullah. (2020). A Review Of 5G Technology: Architecture, Security and wide Applications. 07. 3440-3471. 10.5281/zenodo.3842353.

9] Pirinen, Pekka. (2014). A Brief Overview of 5G Research Activities. 10.4108/icst.5gu.2014.258061.

10] Redana, Simone & Kaloxylos, Alexandros & Galis, Alex & Rost, Peter & Marsch, Patrick & Queseth, Olav & Jungnickel, Volker & Tao, Chen & Fang-Chun, Guo & Van der Veen, Hans. (2016). View on 5G Architecture. 10.13140/RG.2.1.3815.7049.

11] Rongpeng Li, Zhifeng Zhao, Xuan Zhou, Guoru Ding, Yan Chen, Zhongyao Wang, and Honggang Zhang (2017)Intelligent 5G: When Cellular Networks Meet Artificial Intelligence published wide DoI:1536-1284/17/$25.00 © 2017 IEEE

12] Shen, Weiming & Shi, Yanjun & Qiaomei, Han & Zhang, Hui. (2019). Potential Applications of 5G Communication Technologies in Collaborative Intelligent Manufacturing. IET Collaborative Intelligent Manufacturing. 1. 10.1049/iet-cim.2019.0007.

13] Sapkale, Pallavi & Kolekar, Uttam. (2018). Mobility Management for 5G Mobile Networks. International Journal of Computer Applications. 182. 1-4. 10.5120/ijca2018918093.

14] Tudzarov, Aleksandar & Janevski, Toni. (2011). Protocols and Algorithms for the Next Generation 5G Mobile Systems. Network Protocols and Algorithms. 3. 10.5296/npa.v3i1.656.

15] Rajiv (2018) Applications of 5G technology published in the International Magazine of Information Technology February 10, 2018

16] L. M. P. Larsen, A. Checko and H. L. Christiansen, "A Survey of the Functional Splits Proposed for 5G Mobile Crosshaul Networks," in IEEE Communications Surveys & Tutorials, vol. 21, no. 1, pp. 146-172, Firstquarter 2019, doi: 10.1109/ COMST .2018.2868805.