

5G TECHNOLOGY AND ADVANCEMENTS IN CONNECTED LIVING- COMPREHENSIVE SURVEY

Dr. Joy Iong Zong Chen,
Professor,
Department of Electrical Engineering
Da-Yeh University, Taiwan.
Email id: jchen@mail.dyu.edu.tw

Abstract: The fifth generation technology is a novel network platform that concentrates not only improving the mobile paradigm but extends the network to aid a huge set of heterogeneous devices and service. This evolving technology would change the present scenario in the world by providing a seamless connection with an increased capacity, lower latency and higher speed. The paper presents the comprehensive survey on the emerging 5G technology and its advancements in connected living.

Keywords: 5G Technology, Connected Living, Advancements, IOT, Cloud and Communication Systems

1. INTRODUCTION

The fifth generation mobile network coined as the 5G network performs a huge set of roles than the previous generations. It not only hoists the mobile network by linking the people, but also interconnects the machines and as well as regulates them. It will elevate the performance along with the efficiency of the network to empower the novel experiences for its users[1-5],

The technology of the 5G is enriched to provide a peak rate with the multi-Gbps, ultra-low latency, colossal capacity and a very uniform user experience[6-9]. To make the introduction more informative, the sections start with the other generation network that were so far supportive and still supporting the mobile devices are presented below in the figure .1

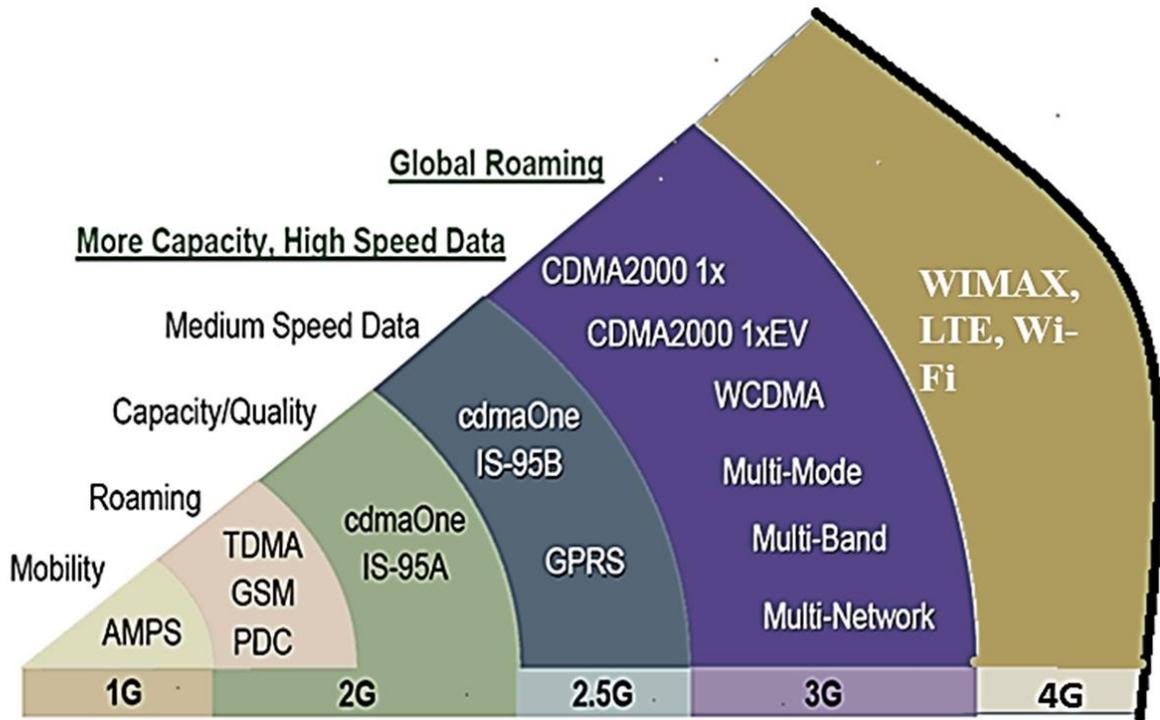


Figure.1 Mobile Network Generations (taken from techiedots and modified)

The upcoming generation is the fifth generation with excellent competence supporting both the software and the consultancy and high connectivity because of the router as well as the switching technology used satisfying the needs that were not considered in the fourth generation,[10-15] it is expected that the Fifth generation would probably support Giga bits of data and supported the LAS-CDMA, OFDM, UWB, MC-CDMA. The table .1 below lists out the key features of the fifth generation networks[16-25].

Key Features of 5G	Description
Services and user cases	The use cases of 5G is differentiated into three main types they are The improved mobile broadband services providing uniform data rates, lower delay and cost- per-bit. The critical communications - that include the managing the critical infrastructure, vehicle and the medical services remotely. Enhanced Internet of things offering a seamless communication or connection between a huge set of sensors with the ability to scale down the data rates, power and the mobility enabling a very lean and low cost solutions.
Speed	It is expected that 5G will deliver the data packets at a speed of 20 Gbps and provide more network capacity by expanding into a new spectrum and a ubiquitous gigabit-class connectivity with the new 5G radio mobile network that is supported by the Giga bit LTE coverage foundation.
Key contributions	Scalable OFDM numerology with 2n scaling of subcarrier spacing, Flexible, dynamic, self-contained TDD subframe design, Advanced, flexible LDPC channel coding, Advanced massive MIMO antenna technologies, Advanced spectrum sharing techniques.
Working	5G similar to 4G LTE operates using the same mobile networking principles, and is based on the OFDM. However, the it enhances the OFDM to deliver a much higher degree of flexibility and scalability.
Uniqueness	unified platform that is more capable uses spectrum better than 4G Is faster Has more capacity Lower latency
Benefits	Enhances today's mobile broadband services, expands mobile networks to support a vast diversity of devices and services and connect new industries with improved performance, efficiency, and cost,

Table .1 Key Features of 5G

The 5G being the next generation mobile technology has not yet placed its feet in the market, all the above information's that are listed in the table is expectation of the fifth generation network[26-30] . Based on the authors review and the information provided by the researches that have developed many novel application with the emerging fifth generation, the key features and the upcoming advancements achieved in paving way for connected living is summarized in the paper[31-36].

The remaining paper is arranged with the survey presenting the advancement that is aimed in the connected living using the 5G in 2 and the conclusion in 3.

2. LITERATURE SURVEY

The section presents the survey on the involvement of 5G network in the connected living; the survey aims in presenting the advancements that could be achieved through the 5G network, in the projects such as the smart home, smart vehicle, smart electricity, smart metering, smart governance, smart city etc. the tabulation in table.2 presents the role of the 5G in connected living.

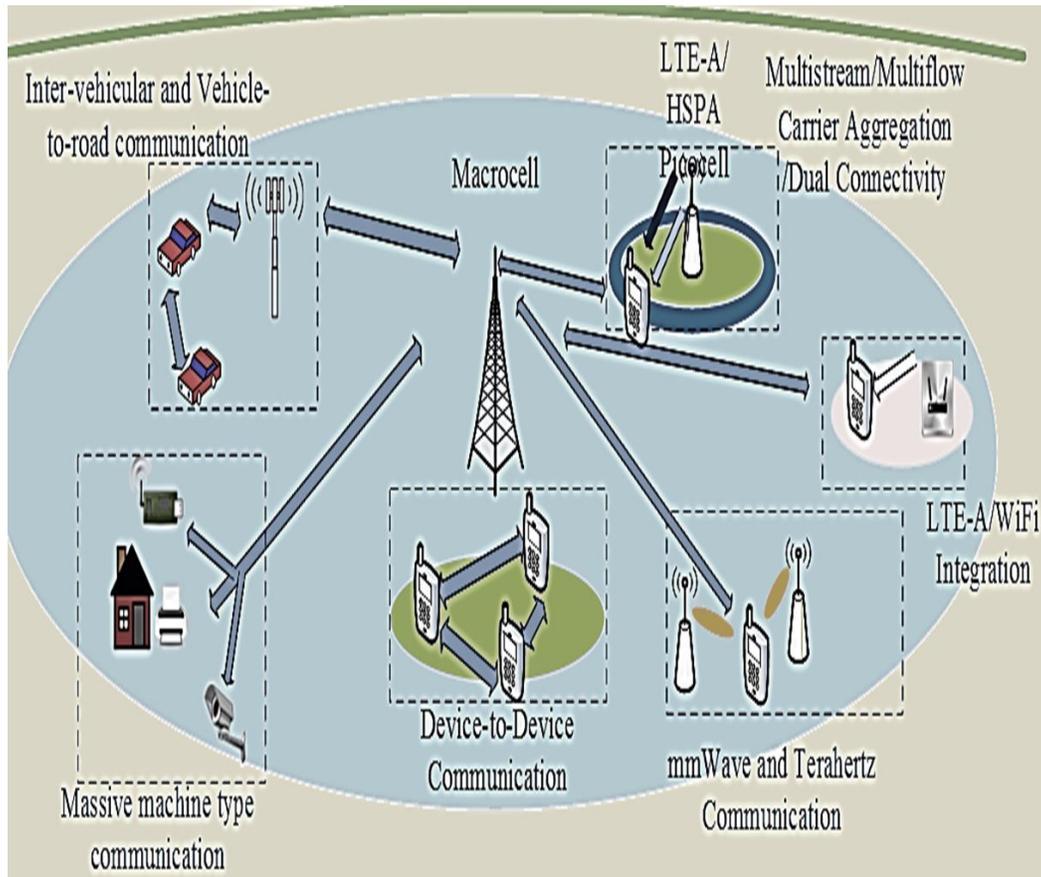


Figure .2 The Fifth Generation Applications (taken from [15] and modified)

The figure. 2 shows the application in which the 5G can be utilized, the table.2 presents the survey on the 5G network enabling a connected living.

Applications Developed with 5G	Publication	Achievements
Smart Vehicles	Kollaikal, et al [1], Usman et al [22], Annunziato et al [25], Mavromati et al [30]	Augmented reality navigation , autonomous cars, easy maintenance, over the air driving.
Smart Homes	Kaneriya, et al [10] Skouby, et al [27]	Allows all the devices to communicate seamlessly reducing the human labors , as well protecting the house from dangers at a very low delay and enabling electricity consumption meeting the requirements in the peak times and paving way for a revenue .
Smart Health Care	Lee, et al [5], Khalil, et al [7], Boric-Lubecke et al [17], Latif et al [18] Smys, S et al [35], Valanarasu, et al [23]	Minimize human intervention and the time required in patient treatment, Creates connectivity
Smart Communication Devices	Rashmi, H. P., and G. Ranjani et al [2], Lema, et al [6], Khurpade et al [9], Agarwal, et al [12], Mehmood, Yasir et al [16], Agiwal, et al [19]	improves cell capacity, boosts user data rate, accommodates the traffic in the future, Seamless device connectivity.
smart Agriculture	Rao, et al [24]	Allows more accurate monitoring, records the health level of crops, looks out for the crop disease, soil status , humidity and the temperature and transmits to the farmer at low latency.
Smart Business	Moqaddamerad, et al [4]	Monitors business routines, maintains the data sheets, provides, implements new marketing ideas, provides high scalability and adaptability to evolving technologies.
Smart Industries	Rao, et al [24]	Accurate monitoring, low latency information transmission, precision in work done. controls and automates process seamlessly
Smart Governance	Memon, Imran et al [3], Usman et al [22] Rao, et al [26]	Speed , data flexibility, analyzes massive amount of data's , scales millions and billions of devices

Table.2 5G Enabled Connected Living

So the 5G remains as the platform of innovations for our future generation with accelerating a breakthrough in the wireless performance enabling a new experience in connectivity, prompting innovations in the industries and the

works. The fifth generation network delivers a unified connectivity in the new distributed computing at the wireless edge offering a low latency, virtually unlimited capacity, and high quality of service. The 5G networks has still not come into use as few areas of the 5G such as the design of unified more capable 5G radio for sub-6ghz and mm wave, LTE advancements, spectrum sharing, local and customized services, connected vehicles to everything safer and more autonomous driving and scaling to satisfy the low power, wide –area internet of things use cases are still under research.

3. CONCLUSION

The fifth generation technologies lay foundation for the pavement of the smart and intelligent world with the resurgence of creativity and new ways to connect with the customers, enabling the users with the live experiences, creating more, collaborative and connected cities. The artificial intelligence and the machine learning with the 5G technology connects provides interconnection between different applications, the paper provides the benefits and the features of the 5G network and provides the survey on the advancements it enables in the connected living. In future the paper is to proceed with the advent of 5G in developing smart cities with the integration of the artificial intelligence and machine learning.

References

- [1] Kollaikal, Praveen, Sridevi Ravuri, and Eddie Ruvinsky. "Connected Cars." *Sutardja Center for Entrepreneurship and Technology* (2015).
- [2] Rashmi, H. P., and G. Ranjani. "5G New Radio and Cloud Radio Access Network."
- [3] Memon, Imran, Hadiqua Fazal, Riaz Ahmed Shaikh, Ghulam Muhammad, Qasim Ali Arain, and Tarwan Kumar Khatri. "Big data, Cloud and 5G networks create smart and intelligent world: A survey." *University of Sindh Journal of Information and Communication Technology* 3, no. 4 (2019): 185-192.
- [4] Moqaddamerad, Sara, Yueqiang Xu, Marika Iivari, and Petri Ahokangas. "Business models based on co-opetition in a hyper-connected era: the case of 5G-enabled smart grids." In *Working Conference on Virtual Enterprises*, pp. 559-568. Springer, Cham, 2016.
- [5] Lee, Sung-Hoon, June-Yeop Lee, and Jung-Sook Kim. "Monitoring System for the Elderly Living Alone Using the RaspberryPi Sensor." *한국디지털콘텐츠학회 논문지* 18, no. 8 (2017): 1661-1669.

- [6] Lema, Maria A., Andres Laya, Toktam Mahmoodi, Maria Cuevas, Joachim Sachs, Jan Markendahl, and Mischa Dohler. "Business case and technology analysis for 5G low latency applications." *IEEE Access* 5 (2017): 5917-5935.
- [7] Khalil, Omar. "A USE CASE OF LOW POWER WIDE AREA NETWORKS IN FUTURE 5G HEALTHCARE APPLICATIONS." (2018).
- [8] Agiwal, Mamta, Abhishek Roy, and Navrati Saxena. "Next generation 5G wireless networks: A comprehensive survey." *IEEE Communications Surveys & Tutorials* 18, no. 3 (2016): 1617-1655.
- [9] Khurpade, Jyoti Mante, Devakanta Rao, and Parth D. Sanghavi. "A survey on IOT and 5G network." In *2018 International Conference on Smart City and Emerging Technology (ICSCET)*, pp. 1-3. IEEE, 2018.
- [10] <http://techiedots.blogspot.com/2013/07/mobile-communication-generations.html>
- [11] Kaneriya, Shriya, Jayneel Vora, Sudeep Tanwar, and Sudhanshu Tyagi. "Standardising the use of duplex channels in 5G-WiFi networking for ambient assisted living." In *2019 IEEE International Conference on Communications Workshops (ICC Workshops)*, pp. 1-6. IEEE, 2019.
- [12] Agarwal, Arun, Gourav Misra, and Kabita Agarwal. "The 5th generation mobile wireless networks-key concepts, network architecture and challenges." *American Journal of Electrical and Electronic Engineering* 3, no. 2 (2015): 22-28.
- [13] Alliance, N. G. M. N. "5G white paper." *Next generation mobile networks, white paper* 1 (2015).
- [14] Cooper, Martin. "5G Technology Briefing." *Itnow* 60, no. 3 (2018).
- [15] http://www.ece.gatech.edu/research/labs/bwn/5G_systems/fig/5G_scenarios.png
- [16] Mehmood, Yasir, Noman Haider, Muhammad Imran, Andreas Timm-Giel, and Mohsen Guizani. "M2M communications in 5G: state-of-the-art architecture, recent advances, and research challenges." *IEEE Communications Magazine* 55, no. 9 (2017): 194-201.
- [17] Boric-Lubecke, Olga, Victor M. Lubecke, Branka Jokanovic, Aditya Singh, Ehsaneh Shahhaidar, and Bryson Padasdao. "Microwave and wearable technologies for 5G." In *2015 12th International Conference on Telecommunication in Modern Satellite, Cable and Broadcasting Services (TELSIKS)*, pp. 183-188. IEEE, 2015.
- [18] 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.
- [19] Agiwal, Mamta, Navrati Saxena, and Abhishek Roy. "Towards connected living: 5G enabled internet of things (IoT)." *IETE Technical Review* 36, no. 2 (2019): 190-202.
- [20] Roy, Abhishek, Navrati Saxena, and Sukhdeep Singh. "5G small cells: The harbinger of the Internet of Things and connected living." In *5G-Enabled Internet of Things*, p. 125. Taylor & Francis Group, 2019.

- [21] Militano, Leonardo, Giuseppe Araniti, Massimo Condoluci, Ivan Farris, and Antonio Iera. "Device-to-device communications for 5G internet of things." *EAI Endorsed Transactions on Internet of Things* 15, no. 1 (2015): 1-15.
- [22] . Usman, Muhammad, Muhammad Rizwan Asghar, and Fabrizio Granelli. "5G and D2D Communications at the Service of Smart Cities." *Transportation and Power Grid in Smart Cities: Communication Networks and Services* (2018): 147-169.
- [23] Valanarasu, Mr R. "SMART AND SECURE IOT AND AI INTEGRATION FRAMEWORK FOR HOSPITAL ENVIRONMENT." *Journal of ISMAC* 1, no. 03 (2019): 172-179.
- [24] Rao, Sriganesh K., and Ramjee Prasad. "Impact of 5G technologies on smart city implementation." *Wireless Personal Communications* 100, no. 1 (2018): 161-176.
- [25] Annunziato, A. "5G vision: NGMN-5G initiative." In *2015 IEEE 81st Vehicular Technology Conference (VTC Spring)*, pp. 1-5. IEEE, 2015.
- [26] Anguraj, Dinesh Kumar, and S. Smys. "Trust-based intrusion detection and clustering approach for wireless body area networks." *Wireless Personal Communications* 104, no. 1 (2019): 1-20.
- [27] Skouby, Knud Erik, and Per Lynggaard. "Smart home and smart city solutions enabled by 5G, IoT, AAI and CoT services." In *2014 International Conference on Contemporary Computing and Informatics (IC3I)*, pp. 874-878. IEEE, 2014.
- [28] Valanarasu, Mr R., and A. Christy. "COMPREHENSIVE SURVEY OF WIRELESS COGNITIVE AND 5G NETWORKS." *Journal of Ubiquitous Computing and Communication Technologies (UCCT)* (2019): 23-32.
- [29] Nunna, Swaroop, Apostolos Kousaridas, Mohamed Ibrahim, Markus Dillinger, Christoph Thuemmler, Hubertus Feussner, and Armin Schneider. "Enabling real-time context-aware collaboration through 5G and mobile edge computing." In *2015 12th International Conference on Information Technology-New Generations*, pp. 601-605. IEEE, 2015.
- [30] Mavromatis, Ioannis, Andrea Tassi, Giovanni Rigazzi, Robert J. Piechocki, and Andrew Nix. "Multi-radio 5G architecture for connected and autonomous vehicles: application and design insights." *arXiv preprint arXiv:1801.09510* (2018).
- [31] Goyal, Parul, and Ashok Kumar Sahoo. "A Roadmap towards Connected Living: 5G Mobile Technology."
- [32] Smys, S., & Ranganathan, G. (2019). ROBOT ASSISTED SENSING, CONTROL AND MANUFACTURE IN AUTOMOBILE INDUSTRY. *Journal of ISMAC*, 1(03), 180-187.
- [33] Pandian, A. Pasumpon. "ENHANCED EDGE MODEL FOR BIG DATA IN THE INTERNET OF THINGS BASED APPLICATIONS." *Journal of trends in Computer Science and Smart technology (TCSST)* 1, no. 01 (2019): 63-73.

- [34] Sivaganesan, D. "DESIGN AND DEVELOPMENT AI-ENABLED EDGE COMPUTING FOR INTELLIGENT-IOT APPLICATIONS." *Journal of trends in Computer Science and Smart technology (TCSST)* 1, no. 02 (2019): 84-94.
- [35] Smys, S., and A. Dinesh Kumar. "Secured WBANs for pervasive m-healthcare social networks." In *2016 10th International Conference on Intelligent Systems and Control (ISCO)*, pp. 1-4. IEEE, 2016.
- [36] Jyothirmai, Pondi, Jennifer S. Raj, and S. Smys. "Secured self-organizing network architecture in wireless personal networks." *Wireless Personal Communications* 96, no. 4 (2017): 5603-5620.