International Journal of Scientific Engineering and Technology ISSN : 2277-1581
Volume No. 7, Issue No. 7, PP : 62-64 1 July 2018

5G Wireless Technology: A Primer

Kelechi G. Eze, Matthew N. O. Sadiku, Sarhan M. Musa
Roy G. Perry College of Engineering, Prairie View A&M University, Prairie View, TX 77446
Email: kelechigodwin9@gmail.com, sadiku@ieee.org, smmusa@pvamu.edu

Abstract : 5G stands for fifth generation wireless technology. It is the latest iteration of cellular technology that has three main features: greater speed, lower latency, and the ability to connect a lot more devices simultaneously. A commercial 5G wireless network is expected to be deployed by 2020. This paper provides a brief introduction to 5G wireless technology.
Key words: 5G wireless technology, evolution from 1G to 5G

Introduction : Wireless communication technology has grown and advanced significantly over the years through research and innovation. The time has come when we can connect various wireless technologies, networks, and applications simultaneously. This latest technology is called 5G. The fifth generation wireless system (or 5G for short) is now the next generation of wireless communication systems. It is the next major phase of mobile telecommunications standards beyond the current 4G. 5G moves us beyond networks design for mobile devices alone toward systems that connect different types of devices operating at high speeds.

The key features of 5G include high throughput, improved spectrum efficiency, reduced latency, better mobility support, and high connection density. It supports interactive multimedia, voice, video, Internet, and other broadband services. To support increased throughput requirements of 5G, new spectrum has been assigned to 5G in mmWave bands. 5G will use Multiple Input Multiple Output (MIMO) to significantly increase network capacity [1].

The move to 5G wireless communication standard is an action in response to the growth of the Internet of Things and the rise in demand for access to video and services over wireless broadband [2]. Although 5G is not expected until 2020, an increasing number of companies are investing now and are creating 5G products. Development of the new mobile wireless standard is being led by companies such as Intel, Qualcomm, Nokia, Ericsson, BT, Verizon, AT&T, and Samsung.

Previous Generations

The world of telecommunication has witnessed drastic changes starting from 1G to 2.5G and from 3G to 5G. A new generation is named (often retroactively) when it denotes a significant forward leap in wireless mobile technologies. Previous generations like 3G were a breakthrough in communications. 1G was analog telecommunications standard introduced in the 1970s for voice communications with a data rate up to 2.4 kps. It used FM and FDMA and a bandwidth of 30 kHz. The major problems with 1G are poor voice quality, poor battery quality, and large phone size.

2G was digital standard, circuit switched technology introduced in 1980s. It used CDMA, GSM, and TDMA technologies. It could only transmit digital voice at 64 kbps, and not data such as email.

Next comes 3G wireless systems, which used Code Division Multiple Access Technique (CDMA). It introduced high-speed Internet access. It used technologies such as W-CDMA and HSPA (high speed packet access). It provided IP connectivity for real-time and non-real-time services. The development of 3G was mainly driven by demand for data services over the Internet.

4G works the same as 3G and may be regarded as the extension of 3G but with a faster Internet connection , more bandwidth, and a lower latency. 4G technologies, such as WiMAX and LTE (Long-Term Evolution), claim to be about five times faster than 3G services. It used technologies like Coded Orthogonal Frequency Division Multiplexing (COFDM), Multiple Input Multiple Output (MIMO) and link adaptation. There are some challenges that cannot be resolved by 4G; these include spectrum crisis and high energy consumption. Research is currently on 5G, which will support IPv6. There have been drastic improvements from 1G, 2G, 3G, and 4G to 5G [3-5]. Figure 1 shows the generations of wireless technology from 1G to 5G.

How 5G Works

As any other cellular network, 5G networks will consist of cells divided into sectors and send data through radio waves. Each cell is connected to a network backbone through a wired or wireless connection. 5G may transmit data over the unlicensed frequencies currently used for Wi-Fi. It promises a smarter, faster, and efficient network. The goal of 5G is to have far higher speeds available, at higher capacity per sector, and at far lower latency than 4G. In order to increase network efficiency, the cell is subdivided into micro and pico cells [6]. 5G will be a new mobile revolution as it is expected to provide gigabit-per-second data rates anytime, anywhere. In a 5G wireless network, every mobile phone will have an IPv6 address depending on the location and network being used. 5G utilizes user-centric network concept World Wide Wireless Web (WWWW) instead of operator- centric as in 3G or service-centric as in 4G [7]. WWWW will be capable of supporting applications and services and interconnected the whole world. 5G includes the latest technologies such cognitive radio, Internet of things, nanotechnology, and cloud computing.

5G technology has the following advanced features [8]:

- Architecture will be device-centric, distributed, programmable, and cloud-based
- High data rates
- One to 10 Gbps connections to end points
- One millisecond end-to-end round trip delaay

- Low battery consumption
- Better connectivity irrespective of location
- Larger number of supporting devices
- Lower cost of infrastructure development

Key Enabling Technologies

The development of 5G will not be from scratch but will gradually build on 4G LTE. Major technologies enabling 5G include:

- *D2D Communication*: Direct connectively is achieved through device-to-device (D2D) technology. 5G cellular network will implement D2D mm wave communication technology to provide high speed data rate, improve coverage, and offer peer-to-peer services. Much research effort has been invested of characterizing D2D connections as part of LTE [9].
- *M2M Communication:* While D3D communication targets mobile radios, machine-to-machine (M2M) expands the scope and facilitates ubiquitous connectivity among mobile devices. It is estimated that there will be over 100 billion connected devices using M2M communications in 5G backbone [10].
- *MIMO:* Multiple-input-multiple-output (MIMO) technology plays a crucial role in 4G and is expected to play an important function in 5G. Massive MIMO extracts the benefits of MIMO on a large scale by increasing the throughput and spectrum efficiency.

Other enabling technologies of 5G include mmWave communication, ultra-dense network (UDN), all-spectrum access (ASA), OFDM (orthogonal frequency division multiplexing), and Internet of things.

Potential Applications

Some of the significant applications of 5G wireless technologies include [11]:

- Virtual reality/augmented reality/tactile Internet
- Autonomous driving/connected cars
- Wireless cloud-based office/multiple-person videoconferencing
- Unified global standard for all
- Network availability anywhere anytime
- Blockchain
- 3D and ultra HD videos
- Smart gird
- Smart surgery and remote medical examination
- Mobile security

In addition, 5G will allow one to pay all bills in a single payment with his/her mobile and vote from his/her mobile.

BENEFITS

5G wireless technology is projected to bring three main benefits [12]:

- *Faster speed*: Data transfer speeds with 5G are projected to be about 10 times higher with 4G. That means significantly faster transmission of images and videos.
- *Shorter delays*: 5G should reduce latency (the time between cause and effect). This will make it possible, for example, to watch high-speed virtual reality video with no delays.
- *Increased connectivity*: 5G technology would will bring faster, more reliable connections for users than 4G/LTE. That means more people and devices will be able to communicate at the same time.

Besides these benefits, 5G has excellent capability to support both software and consultancy. It has high data rate at the edge of the cell and better coverage area. It has low battery consumption. It is beneficial for the government, as it can make governance easier, and for the citizen, as it can provide Internet connectivity anytime anywhere.

Challenges

The transition from 4G to 5G presents several transformational challenges which must be tackled to fully realize the 5G vision. There are challenges faced with the new technologies enabling 5G. There are also challenges with the integration of this technology to provide services in different application scenarios.

Some have criticized 5G for its high projected cost and that it is incompatible with the previous generations. Just as 2G phones could not connect to 3G or 4G networks, 3G and 4G phones will not connect to a 5G network. One is forced to buy a new phone which is likely to be more expensive than 4G/LTE service. To address these challenges, we need a drastic change in the design of cellular architecture. We also need to meet 5G system performance requirements such Mfentocells, stringent latency, network scalability, very long battery life, and green communications. It is a challenge to satisfy these requirements and minimize costs at the same time [13,14].

Conclusion

The 5G wireless technology is a multipurpose wireless network for mobile, fixed and enterprise wireless applications. It incorporates all type of advanced features that makes it powerful and in huge demand in near future. Many tests and trials need to be conducted before implementing 5G. 5G technology is still in development stage. It has a bright future and will be a revolution in the mobile market.

References

i. *"5G," Wikipedia, the free encyclopediahttps://en.wikipedia.org/wiki/5G*
ii. *"5G Development with Matlab," https://www.mathworks.com/content/dam/mathworks/ebook/gated/5G_ebook.pdf*
iii. *A. Agarwal, G. Misra, and K. Agarwal, "The 5th generation mobile Wireless networks- Key concepts, network architecture and challenges,"http://pubs.sciepub.com/ajeee/3/2/1/*
iv. *M. H. Alsharif and R. Nordin, "Evolution towards fifth generation (5G) wireless networks: Current trends and challenges in the deployment of millimeter wave, massive MIMO, and small cells," Telecommunication Systems, vol. 64, 2017, pp. 617-637.*
v. *M. R. Bhalla and A. V. Bhalla, "Generations of mobile wireless technology: A survey," International Journal of Computer Applications, vol. 5, no. 4, August 2010, pp. 26-32.*
vi. *R. S. Sapakal and S. S. Kadam, "5G mobile technology," International Journal of Advanced Research in Computer*

Engineering & Technology, vol. 2, no. 2, February 2013, pp. 568-571.

vii. "How 5G technology works,"https://www.rfpage.com/how-5g-technology-works/

viii. D. H. Latha et al., "A study on 5th generation mobile technology – Future network service," International Journal of Computer Science and Information Technologies, vol. 5, no. 6, 2014, pp. 8309-8313.

ix. S. Andreev, "Delivering uniform connectively and service experience to converged 5G wireless networks," Proceedings of the IEEE World Forum on Internet of Things, 2014, pp. 323-324.

x. M. H. Alsharif et al., "How to make key wireless technologies environmental friendly: a review," Transactions of Emerging Telecommunications Technologies, vol. 29, 2018.

xi. "Understanding 5G: Perspectives on future technological advancements in mobile,"

xii. https://www.gsmaintelligence.com/research/?file=141208-5g.pdf&download

xiii. A. Campanaro, "What is 5G? The next wireless revolution explained,"

xiv. https://www.nbcnews.com/mach/tech/what-5g-next-wireless-revolution-explained-ncna855816

xv. C. X. Wang et al., "Cellular architecture and key technologies for 5G wireless communication networks," IEEE Communications Magazine, February 2014, pp.

xvi. 122-130.

xvii. N. Marchetti, "Towards 5th generation wireless communication systems,"

xviii. *https://www.researchgate.net/publication/293593557_Towards_5th_Generation_Wireless_Communication_Systems*

About the authors

Kelechi G. Eze (keze@student.pvamu.edu) is a doctoral student at Prairie View A&M University, Texas. He is a student member of IEEE. His research interests include Internet of things security, data security and privacy, blockchain technology, wireless sensor networks, and machine learning.

Matthew N.O. Sadiku (sadiku@iee.org) is a professor at Prairie View A&M University, Texas. He is the author of several books and papers. He is an IEEE fellow. His research interests include computational electromagnetics and computer networks.

Sarhan M. Musa (smmusa@pvamu.edu) is a professor in the Department of Engineering Technology at Prairie View A&M University, Texas. He has been the director of Prairie View Networking Academy, Texas, since 2004. He is an LTD Sprint and Boeing Welliver Fellow.

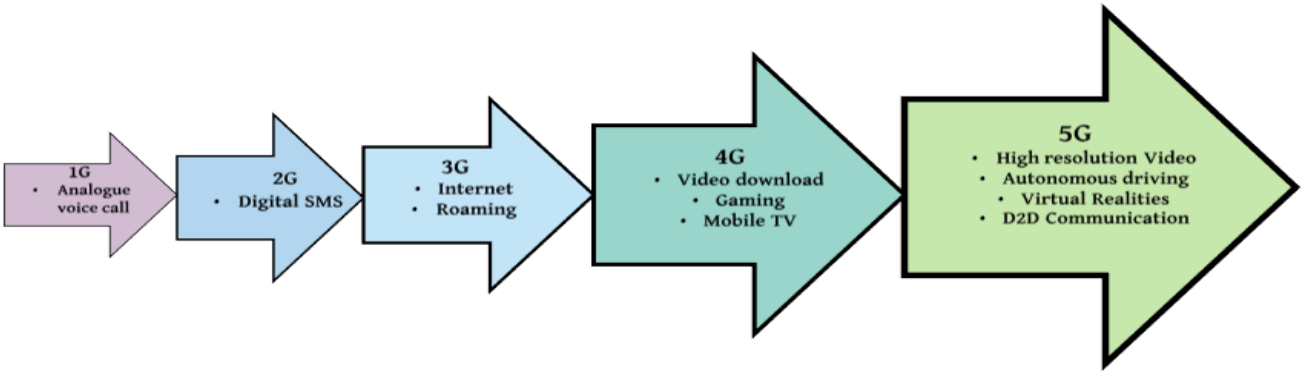

Figure 1 Generations of wireless network.