American Journal of Systems and Software, 2014, Vol. 2, No. 4, 108-112
Available online at http://pubs.sciepub.com/ajss/2/4/5

DOI:10.12691/ajss-2-4-5

5G Network a New Look into the Future: Beyond all Generation Networks

Sidhartha Sankar Sahoo*, Malaya Kumar Hota, Kalyan Kumar Barik

Department of Electronics and Telecommunication Engineering, Synergy Institute of Engineering & Technology, Dhenkanal 759001, Odisha, India
*Corresponding author: sidhartha.nmiet@gmail.com

Received June 08, 2014; Revised August 04, 2014; Accepted August 20, 2014

Abstract We're still in the middle of the 4G revolution, in that the superfast mobile data service is still in its infancy in both coverage and speed capabilities. Customers of telecommunication demand more and more from their technology. To maintain such a powerful system, we require a high speed wireless connectivity. The drawbacks of 4G mobile technology led the researchers and developers to arise with more advanced and efficient technologies. 5G mobile technology is the next generation of wireless networks that will totally replace existing 4G networks. This paper focuses on all preceding generations of mobile communication along with fifth generation technology. Fifth generation network provides reasonable broadband wireless connectivity (very seamless high speed). The paper throws light on the difference from 1G to 5G.

Keywords: *1G, 2G, 3G, 4G, 5G, 5G architecture*

Cite This Article: Sidhartha Sankar Sahoo, Malaya Kumar Hota, and Kalyan Kumar Barik, "5G Network a New Look into the Future: Beyond all Generation Networks." *American Journal of Systems and Software*, vol. 2, no. 4 (2014): 108-112. doi: 10.12691/ajss-2-4-5.

1. Introduction

Wireless technologies are going to take new dimension in our lives. The wireless broadband will soon become readily available to everybody while, being at home, driving the car, sitting in the park, and even on a pleasure boat in the middle of a lake. And because of this, our need to have information at anytime and to be connected at all places, all the time, will be satisfied. The world of universal, uninterrupted access to information, entertainment and communication will open new dimension to [1] our lives and change our life style significantly. In this way 5G is the new evolution of this new era. 5G is the name currently being given to the next generation of mobile data connectivity that will come after the last drop has been wringed from 4G. It will provide unbelievably fast broadband speeds, but more importantly it will have enough capacity wherever you go to perform every function you want it to without a drop in speed or connection, no matter how many people are connected at the same time.

2. Evolution

Mobile communication has become more popular in last few years due to fast revolution in mobile technology. This revolution is due to very high increase in mobile customers [2]. This revolution is from 1G - the first generation, 2G- the second generation, 3G - the third generation, 4G - the fourth generation, and then the 5G - the fifth second generation as shown in Figure 1.

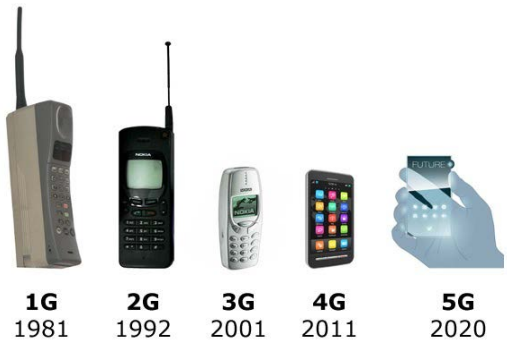

Figure 1. Evolution of mobile generation

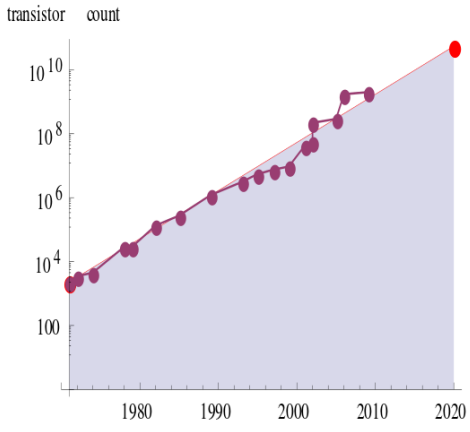

Figure 2. Moore's law

Moore's law: "Moore's Law" is stated as: "the number of transistors that can be fit onto a square inch of silicon doubles every 12 months." Moore's law describes a long-term trend in the history of computing hardware but it also prove true for wireless technologies. From 1G to 4G wireless bit rate has increased from 2.4 Kbps to 100 Mpbs. The statement of Moore's Law is shown in Figure 2.

Similarly considering to the no. of transistors, Moore's Law can be shown in terms of use of bits per seconds (bps) and no. of users as shown in Figure 3 and Figure 4 respectively.

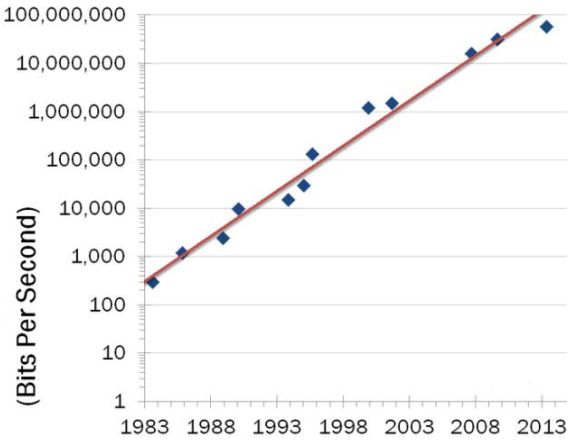

Figure 3. Use of bps over year

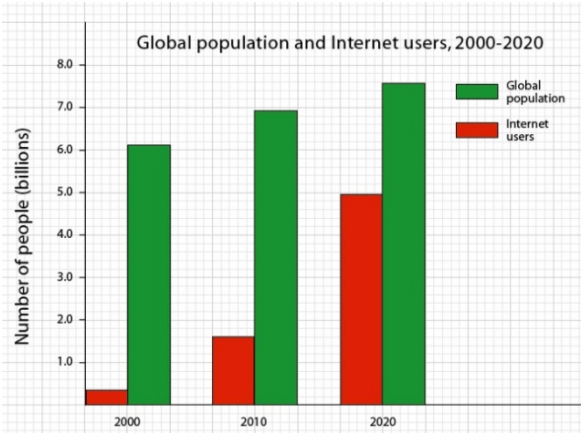

Figure 4. No. of user over year

2.1. First Generation (1G)

The first generation, 1G wireless mobile communication systems, was introduced in the early 1980s and completed in the early 1990s. 1G was analog and supported the first generation of analog cell phones with the speeds up to 2.4 kbps. The prominent ones among 1G system were advanced mobile phone system (AMPS), Nordic mobile telephone (NMT), and total access communication system (TACS). It uses analog radio signal which have frequency 150 MHz, voice call modulation is done using a technique called Frequency-Division Multiple Access (FDMA). It has low capacity, unreliable handoff, poor voice links, and no security at all since voice calls were played back in radio towers, making these calls susceptible to unwanted eavesdropping by third parties [2,3].

2.2. Second Generation (2G)

The second generation, 2G system, fielded in the late 1980s and finished in the late 1990s, was planned mainly for voice transmission with digital signal and the speeds up to 64kbps. GSM and CDMA IS 95 were prominent technologies. It uses digital signals for voice transmission and has speed of 64 kbps. It provides facility of SMS (Short Message Service) and use the bandwidth of 30 to 200 KHz [2,3].

2.2.1. (2.5G)

2.5G is used to describe 2G-systems that have implemented a packet switched domain in addition to the circuit switched domain. 2.5 G can provide data rate, up to 144 kbps. GPRS, EDGE and CDMA 2000 were 2.5 technologies [3].

2.3. Third Generation (3G)

The third generation, 3G wireless system, was developed in the late 1990s and might be well-done in the late 2000s. 3G is not only provided the transmission speeds from 125 kbps to 2 Mbps, but also included many services, such as global roaming, superior voice quality and data always add-on. UMTS, CDMA, EVDO, HSPA are 3G technologies. In 3G the data are sent through Packet Switching technology and Voice calls are interpreted through Circuit Switching technology. Along with verbal communication it includes internet services, access to television/video streaming, GPS (Global Positioning System) and new services like Global Roaming. It operates at a range of 2100 MHz and has a bandwidth of 15-20 MHz used for High-speed internet service, video chatting [3].

2.4. Fourth Generation (4G)

The fourth generation (4G) is a conceptual framework for high speed wireless network that can transmit multimedia and data to and interface with wire-line backbone network perfectly. The speeds of 4G can theoretically be promised up to 1 Gbps. LTE is considered as 4G technology. 4G offers a downloading speed of 100Mbps. 4G provides same feature as 3G and additional services like Multi-Media Newspapers, to watch T.V programs with more clarity and send Data much faster than previous generations [3,4]. 4G is being developed to accommodate the QOS and rate requirements set by forthcoming applications like wireless broadband access, Multimedia Messaging Service (MMS), video chat, mobile TV, HDTV content, Digital Video Broadcasting (DVB), minimal services like voice and data, and other services that utilize bandwidth.

4G networks are integrated with one core network and several radio access networks. A core interface is used for communication with the core network and radio access networks, and a collection of radio interfaces is used for communication with the radio access networks and mobile users. This kind of integration combines multiple radio access interfaces into a single network to provide seamless roaming/ handoff and the best connected services.

The main distinguishing factor between 3G and 4G is the data rates. 4G can support at least 100 Mbps peak rates in full-mobility wide area coverage and 1 Gbps in low-mobility local area coverage. The speeds of 3G can be up to 2 Mbps, which is much lower than the speeds of 4G.

However, 4G standard will base on broadband IP-based entirely applying packet switching method of transmission with seamlessly access convergence. It means that 4G integrated all access technologies, services and applications can unlimitedly be run through wireless backbone over wire-line backbone using IP address. But 5G will be the new entrance for real world wireless or called WWW: World Wide Wireless Web".

2.5. Fifth Generation (5G)

This generation is expected to be rolled out around 2020. 5G network technology will open a new era in mobile communication technology. The 5G mobile phones will have access to different wireless technologies at the same time and the terminal should be able to combine different flows from different technologies. 5G is predicted to be an intelligent technology capable of interconnecting the entire world without limits.

At present, 5G is not a term officially used for any particular specification or in any official document yet made public by telecommunication companies or standardization bodies likes Wi-Max Forum or ITU-R. New release will further enhance system performance and add new capabilities with new application areas [5,6,7]. 5G would be the next major phase of mobile telecommunications standards beyond the 4G/IMT-Advanced standards. The 5G technologies include all type of advanced features which make 5G mobile technology most powerful and in huge demand in near future. Users can hook their 5G technology cell phones with their Laptop to get broadband internet access. Some of the applications, benefiting from mobile connectivity are home automation, emergency response, intelligent shopping smart transportation sustainable urban environment, smart product management security and e-books. The details Synopsis of evolution are shown in Table 1.

Table 1. Synopsis of evolution

Generation→ Features↓	1G	2G	3G	4G	5G
Deployment	1970 – 1980	1990 - 2001	2001-2010	2011	2015-20 onwards
Data Rates	2kbps	14.4-64kbps	2Mbps	200 Mbps to 1 Gbps	1Gbps and higher
Technology	Analog Cellular Technology	Digital Cellular Technology: Digital narrow band circuit data Packet data	Digital Broadband Packet data: CDMA 2000 EVDO UMTS EDGE	Digital Broadband Packet data: WiMax LTE Wi-Fi	wwww Unified IP seamless combination of broadband LAN PAN MAN WLAN
Service	Analog voice service No data service	Digital voice with higher clarity SMS, MMS Higher capacity packetized data	Enhanced audio video streaming video conferencing support Web browsing at higher speeds IPTV support	Enhanced audio, video streaming IP telephony HD mobile TV	Dynamic Information access, Wearable devices with AI Capabilities
Multiplexing Switching	FDMA	TDMA, CDMA	CDMA	CDMA	CDMA
Core Network	PSTN	PSTN	Packet N/W	Internet	Internet
Standards	MTS AMTS IMTS	2G:GSM 2.5:GPRS 2.75:EDGE	IMT-2000 3.5G-HSDPA 3.75G:HSUPA	Single unified standard LTE, WiMAX	Single unified standard
WEB Standard		www	www(IPv4)	www (IPv4)	wwww (IPv6)
Handoff	Horizontal only	Horizontal only	Horizontal & Vertical	Horizontal & Vertical	Horizontal & Vertical
Shortfalls	Low capacity, Unreliable handoff, Poor voice links, Less secure	Digital signals were reliant on location & proximity, required strong digital signals to help mobile phones	Need to accommodate higher network capacity	Being deployed	Yet to be implemented

3. Key Concepts of 5G and beyond 4G Wireless Communications [5,6,7]

a. Massive Dense Networks also known as Massive Distributed MIMO providing green flexible small cells 5G Green Dense Small Cells. A transmission point equipped with a very large number of antennas that simultaneously serve multiple users. With massive MIMO multiple messages for several terminals can be transmitted on the same time-frequency resource, maximizing beam forming gain while minimizing interference.

b. Advanced interference and mobility management, achieved with the cooperation of different transmission points with overlapped coverage, and encompassing the option of a flexible usage of resources for uplink and downlink transmission in each cell, the option of direct device-to-device transmission and advanced interference cancellation techniques.

c. Efficient support of machine-type devices to enable the Internet of Things with potentially higher numbers of

connected devices, as well as novel applications such as mission critical control or traffic safety, requiring reduced latency and enhanced reliability.

d. Pervasive networks providing Internet of things, wireless sensor networks and *ubiquitous computing*: The user can simultaneously be connected to several wireless access technologies and seamlessly move between them. These access technologies can be 2.5G, 3G, 4G, or 5G mobile networks, Wi-Fi, WPAN, or any other future access technology. In 5G, the concept may be further developed into multiple concurrent data transfer paths.

e. Multi-hop networks: A major issue in beyond 4G systems is to make the high bit rates available in a larger portion of the cell, especially to users in an exposed position in between several base stations. In current research, this issue is addressed by cellular repeaters and macro-diversity techniques, also known as group cooperative relay, where also users could be potential cooperative nodes thanks to the use of direct device to-device (D2D) communications.

f. Wearable devices with AI capabilities such as smart watches and optical head-mounted displays for augmented reality.

g. Li-Fi (a portmanteau of *light* and *Wi-Fi*) is a massive MIMO visible light communication network to advance 5G. Li-Fi uses light-emitting diodes to transmit data, rather than radio waves like Wi-Fi.

4. 5G architecture

Up to 4G, the wireless evaluation is following path of Moore's law. The newer generations were identified by increased bit rate. (2G (9.6 Kpbs) to 4G (1Gbps)). There is belief that, 5G will be generation will defy the Moore law and it will be phase of integration of network technologies, rather expansion or evaluation of new wireless standard. The architectural diagram is shown in Figure 5.

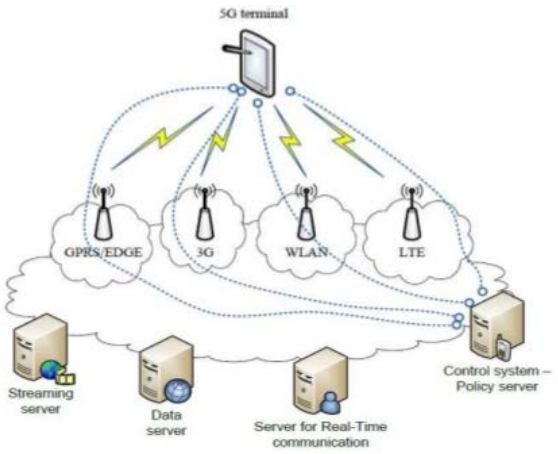

Figure 5. Architectural diagram of 5G

4.1. Services

The services behind 5G architecture are

4.1.1. GPRS (General Packet Radio Service)

- It is used to transmit data at 60kb/sec.
- It also consumes less battery during sending and receiving mail or to browse internet.

4.1.2. EDGE (Exchanged Data Rate for GSM Evolution)

- It is an advanced version of GPRS.
- It provides a data speed of 473kb/sec.

4.1.3. 3G

- 3G makes it possible to do video call on mobile network.
- It also provides efficient way to browse internet on mobile network.

4.1.4. WLAN (Wireless Local Area Network)

- WLAN provides short range, high speed wireless data connection between mobile data device using radio signal.

4.1.5. LTE (Long Term Evolution)

- LTE is a standard for mobile communication for high speed data transmission for mobile network.
- It has speed up to 100mbps.

4.2. Technologies of 5G

The technologies behind 5G architecture are [5,6]
a. NanoEquipment
b. Cloud computing
c. IP platform

4.2.1. NanoEquipment

In 5G mobile equipment is generally reffered as nano equipment. This mobile is designed by nano core technology which has ubiquitous specification as given below

- Self cleaning: The mobile cleans by itself
- Self charged: the mobile derives its power from sun, water or air.
- Flexible: not breakable
- Environmental sensor: The mobile gives details about weather, temperature, pollutiion.

4.2.2. Cloud Computing

Cloud computing is a technology that uses the internet and central remote server to maintain data and applications. Cloud computing allows consumers and business to use applications without installation and access their personal files at any computer with internet access. The development of cloud computing provides operators with tremendous opportunities. Since cloud computing relies on the networks, it shows the significance of networks and promotes network development.

4.2.3. IP Platform

IP architecture acts as an essential part of 5G network. The IP Network is an evolution of the 4G system to meet the increasing demands of the mobile telecommunications market. IP provides a continued evolution and optimization of the system concept in order to provide a competitive edge in terms of both performance and cost. The key benefits of flat IP architectures are:

- lower costs
- universal seamless access

- improved user experience
- reduced system latency
- decoupled radio access and core network evolution

5. Objectives of 5 G

5.1. Superior Service Quality and User Experience

Consumer expectations for mobile broadband service quality are growing in parallel with traffic complexity and increase usage. Complex and constantly evolving multi-vendor networks and services are placing considerable demands on service management. The focus shifting towards managing the delivery of high-quality services i.e., support service centric and user-centric management [5,6].

5.2. Reliable Connectivity Experience

The next wave of the Digital Society will be characterized by an ICT network's capability for immediate service availability and on-demand adaptability. An instant immediacy in mobile services will lay the foundation for a whole new set of mobile apps to proliferate and push the capabilities of communications beyond what is currently possible. Widespread adoption of M2M services will be encouraged when there would be provision of higher network capacity required for handling enormous connections [5,6].

5.3. Ability to Handle Upsetting Growth in Network Capacity

Server workloads are growing by 10% a year. Network bandwidth demand is growing by 35%. Storage capacity is growing by 50%. Power costs growth is 20%. Throwing more capacity at demand is not the solution; there is a need to optimize capacity in new ways. Over 1.5 billion Web pages are accessible, 450,000 iPhone apps are being accessed, over 200,000 Android apps are being used, and 10,500 radio stations are existing [5,6].

6. Conclusion

At the present time Mobile equipments are designed with higher processing power, more inbuilt and supporting memory, longer battery life, more screen resolution and more camera power for the same applications. The 5G includes most recent technologies such as SDR, nano technology, cognitive Radio, cloud computing and based on all IP platforms. Finally 5G will bring evaluation of active infra sharing and managed services and eventually all existing network operators will be MVNOs (Mobile Virtual Network Operators). We hope that this Paper helps to promote stronger links between people working in different fields creating future concepts of mobile communication, Internet services, Cloud computing, All IP network, and Nanotechnologies.

References

[1] Nascimento, Andrea, et al. "A characterization of mobility management in user-centric networks", *Smart Spaces and Next Generation Wired/Wireless Networking.* Springer Berlin Heidelberg, pg. 314-325, 2013.

[2] Mohd. Maroof Siddiqui "Vision of 5G Communication", A. Mantri et al. (Eds.): *HPAGC 2011, CCIS 169, © Springer-Verlag Berlin Heidelberg*, pp. 252–256, 2011.

[3] Akhilesh Kumar Pachauri, Ompal Singh, "5G Technology–Redefining wireless Communication in upcoming years", International Journal of Computer Science and Management Research Vol 1 Issue 1 Aug 2012.

[4] Arun Agarwal, and Kabita Agarwal, "*The Next Generation Mobile Wireless Cellular Networks – 4G and Beyond.*" *American Journal of Electrical and Electronic Engineering,* vol. 2, no. 3 (2014): 92-97.

[5] David Ott, Shilpa Talwar, Intel Labs, University Research Office, "Exploring Next Generation Wireless (5G): Transforming the user Experience", 2013.

[6] Suvarna Patil, Vipin Patil,.Pallavi Bhat, "A Review on 5G Technology", *International Journal of Engineering and Innovative Technology*, Volume 1, Issue 1, January 2012.

[7] Reshma S. Sapakal, Sonali S. adam, "5G Mobile Technology", *International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)* Volume 2, Issue 2, February 2013.