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Review of Generations and Physics of Cellphone Technology

Cudjoe Dan

School of Economics and Management, Beijing University of Technology, Beijing, 100124, P.R. China (PhD Student)

Abstract Cellphones present a type of technology that has been around for little over fifty years. However, it has been recently that many people began to use cellphones as major part of their everyday life. In the past, cellphones were used by business people to conduct their business. In today's society, one member of every residence owns a cellphone. Cellphones are interesting, useful and play major role in our lives by bringing people close together and keeping in constant touch with one another. Therefore, there is the need to know how cell phone works and its generations. The purpose of this paper is to review, the history, generations and physics (how cell phone works and parts of cell phone) of cell phone technology. Also how cell phone changed the world is discussed in this paper.

Keywords Society, Technology, Physics

1. Introduction

Cellphone technology has gone through a tremendous change. The cellphone technology as days go by get new looks as experts always come out with new ideas to give a new look to present technology. Since the invention of telephone the technology has advanced with new technologies coming up each passing day.

In recent times, cellphone has become a necessity in Chinese society, African society and around the globe.

At the end of 2012, an estimated number of 6.8 billion mobile subscriptions were recorded according to the International Telecommunication Union (February 2013). This number is equivalent to 96% of the world's population 7.1 billion according to the International Telecommunicati on Union (ITU). [4]

A research conducted by the Portio Research which is captured in the excellent Mobile Fact Book in 2013 predicts that cellphone subscription world wide will hit 7.5 billion by the end of 2014 and 8.5 billion by the end of 2016. [8]

When the telephone entered cultural life early in the century, it primary served as an extension of face to face relations. Neighbors and business collegues could communicate with each oother without inconvenience of transporting themselves bodily. [12]

In the developed world, cellphone subscription is increasingly reaching its peak. Research shows that at least one cell phone subscription per person is recorded in the developed countries. Cell phone entry in the developed country stands at about 128% of their population. This means that the increase in the cellphone subscription in the developing countries is as a result of growth in demand, led by rapid mobile adoption in China and India, the world's most populous nations. Cellphone penetration in the developing countries is around 89% of the population according to ITU.

* Corresponding author:
dancudjoe@rocketmail.com (Cudjoe Dan)
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2. Cell Phone Technology: Brief History

Cell phones have evolved immensely since 1983, both design and function. [16] A decade after Cooper made the first call, the U.S. Federal Communication approved Motorola's DynaTAC phone for public use. In 1984, the first DynaTAC became available for consumers. [18]

Phones continued to shrink, even as they got more power internal components. They went from car phones to truly mobile devices; hand held, but connected to a bulky receiver unit. The first portable hand held phones emerged in 1980s, getting smaller and more efficient by the 1990s. The history of cell phones is fascinating and rich. Everything from phone's batteries, speaker and inner electronic circuitry was enhanced and miniaturized until small hand-held phones replaced the bigger and bulkier "bricks". [10]

Many people believe that cell phone technology was first conceived and developed in the late 80s and early 90s. After all, the first time many people saw a mobile phone (car phone) in use was in Ferris Bueller's Day Off! But in actuality, engineers have known how to make cell phone since 1947; they just didn't have the technology to make it work. [1]

Dr. Martin Cooper, a Motorola researcher demonstrated the first cell phone in 1973. This phone weighed in at 2kilograms, or 4.4 pounds. By 1990 about 12.4 million people worldwide owned a cell phone subscription. Less than 20 years later in 2009, the number of subscription rose to 4.6billion worldwide. Cell phone history has evolved overtime, by including additional features such as mobile web, email, Bluetooth communication, touch screen access, camera, GPS navigation, MP3 player and radio. [14]

Bell labs and Motorola were both involved in a dramatic race to see who could invent the first viable cell phones. While Bell labs had installed innovative radio systems into police cars, these devices were far too large for anyone to carry around and were thus impractical as a truly mobile telephone.

3. Generations of Cell Phone

From the roots of analogue based first generation service (1G) to today's truly broadband-ready LTE networks (now accepted as 4G), the wireless industry is on a path that promises some great innovation in our future. [3]

Below are the various generations of cell phone technology up to date:

3.1. First Generation (1G)

This is the name given to the first generation of mobile telephone network. These systems used analogue circuit-switched technology, with Frequency Division Multiple Access (FDMA), and worked mainly in the 800-900 MHz frequency bands. The networks had a low traffic capacity, unreliable handover, poor voice quality and poor security. [20] The first commercially available cellular networking using 1G standard was introduced by Nippon Telegraph and Telephone (NTT) in 1979 in Japan. NTT is also shareholder and technology provider for TATA DOCOMO in India. [13]

3.2. Second Generation (2G)

The first digital cell phones were the second generation (2G) of cellular technology. Digital phones use the same radio technology as analogue phones, but they used it differently. Analogue systems don't fully use the signal between the phone and the cellular network. [17] 2G technologies enabled the various mobile phone networks to provide services such as text messages, picture messages and multimedia messages (MMS). Second generation technology is more efficient. It holds sufficient security for both the sender and receiver. All text messages are digitally encrypted. This digital encryption allows for the transfer of data in such a way that the intended receiver can receive and read. [22] 2G makes use of a Compression-decompression algorithm (CODEC) to compress and multiplex digital voice data. Through this technology, a 2G network can pack more calls per amount of bandwidth as a 1G network. 2G cell phones units were generally smaller than 1G unites, since they emitted less radio power. [7]

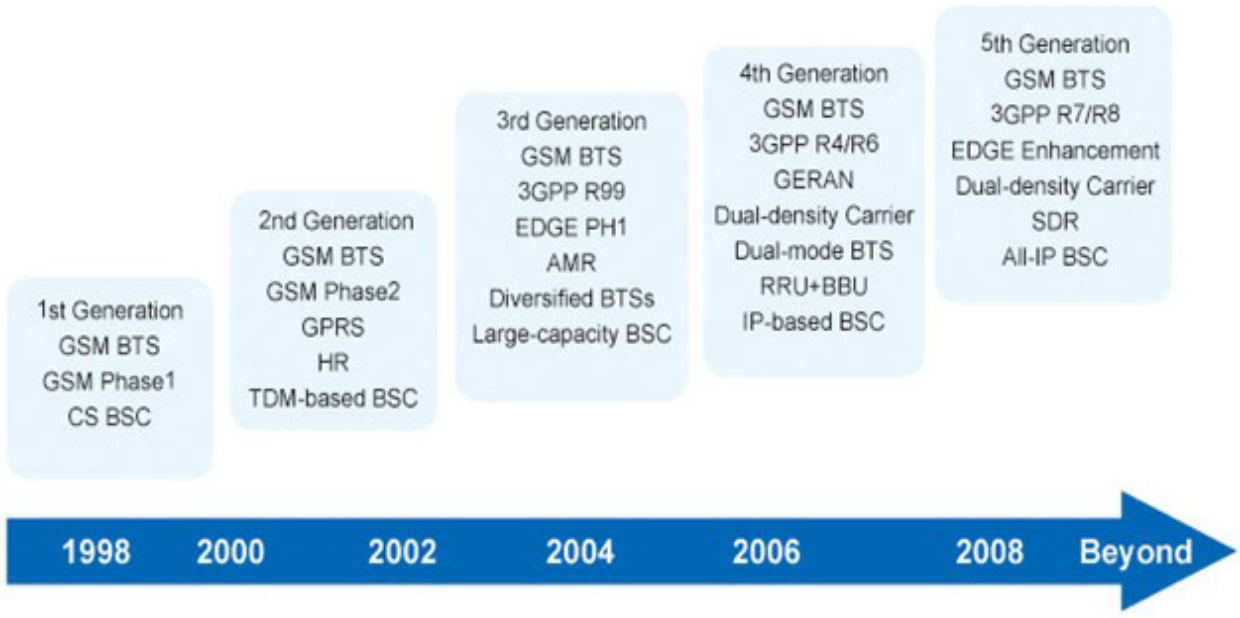

Figure 1. Growth history of cell phone technology generations (Source: http://www.mechanicalengineeringblog.com)

3.3. Third Generation (3G)

This refers to the third generation of mobile telephone technology. Third generation, as the name suggests, follows two earlier generations. Third generation partnership project (3 GPP) was formed in 1998 to faster deployment of 3G network that descend from GSM. 3GPP technologies evolved follow: General packet Radio Service (GPRS) offered speed up to 144kbps, Enhanced Data rates for Global Evolution (EDGE) reached up to 384kbps, UMTS Wideband CDMA (WCDMA) offered downlink speeds up to 1.92Mbps, High speed Downlink packet Access (HSDPA) boosted the downlink to 14Mbps and LTE Evolved Terrestrial Radio Access (E- UTRA) is aiming for 100Mbps [11] 3G enables devices such as mobile phones and mobile dongles to deliver broadband-speed internet. [27] 3G works by parcelling the data sent on the network into small packets. These packets are then assembled in the correct order at the receiver's end. This is very different from normal 2G technology in which small portion of the network is reserved for a call. 3G technology also enables mobile service providers to know the location of the handset using the service. [24]

3.4. Fourth Generation (4G)

This is the term used to refer to the fourth generation of mobile wireless services that has been defined by the ITU and its Radio communication Sector (ITU-R) and established as an agreed upon and globally accepted definition in IMT-Advanced. [5] The speed and standards of this technology of wireless needs to be at least 100 Megabits per second and up to 1 Gigabit per second to pass as 4G. It also needs to share the network resources to support more simultaneous connections on the cell. As it develops, 4G could surpass the speed of the average wireless broadband home Internet connection. Few devices are capable of the full throttle yet. Coverage of true 4G is limited to large metropolitan areas. [25] 4G is a set of standards of mobile technology that entail increased data transfer speeds, enhanced security, and reduced blips in transmission when a device moves between areas covered by different networks. [26] 4G is faster than 3G.

China through their Ministry of Industry and Information Technology has awarded china mobile Ltd, China Unicom Hong Kong Ltd and china Telecom corp. Ltd the license to operate on 4G network. The ministry has issued the licenses for TD-LTE standard to the country's three carriers. The announcement only mentioned the licenses for the TD-LTE standard, not the FD-LTE standard which is widely used globally. The licenses will mostly benefit china mobile whose 4G network is widely based on TD-LTE. [2]

According to a report by Nanfang Daily, the operator said during the Global Partner Conference that in 2014, it will invest 50 billion Yuan (US$8.18 billion) on 500,000 base stations and other infrastructure expenses. Its customers in Beijing, Shanghai, and 14 other cities will have 4G accesses by end-2013, while another 340 cities will be connected by the end of 2014, said China Mobile CEO Xi Guohua. The operator in May, 2013 had initiated large-scale 4G trials in Shanghai, where it built 1,000 base stations to cover the Inner Ring region. Xi added that China Mobile was forecasting to sell over 100 million pieces of LTE terminals, which will likely be heavily subsidized. In comparison, its competitors China Telecom and China Unicom are still advertising their 4G services without providing any substantial details about their rollout.

Telecommunication equipments giant, Huawei, has set up the first 4G TD-LTE network in Ghana to enable faster video streaming and Internet downloads for its customers in the country. Huawei demonstrated the new services, which also enables video conferencing, before delegates at the International Conference Centre and the Office of the President Annex in Accra, Ghana between 2-4 October, 2013. Huawei's 4 G TD-LTE networks will make Ghana communication more effective, efficient and transparent, say officials of the telecommunication equipments giant. [15]

Table 1. Comparison of 3G, 4G and 5G technology features (source: from reference number 6)

Technology Features	3G	4G	5G
Data Bandwidth	2Mbps	2Mbps to 1Gbps	1Gbps & Higher
Standards	WCDMA CDMA- 2000	Single unified standard	Single Unified Standard
Technology	Broad bandwidth CDMA, IP Technology	Unified IP and seamless combination of broadband. LAN/WAN/PAN and WLAN	Unified and seamless combination of broadband. LAN/WAN/PAN/ WLAN/ and WWWW
Service	Integrated high quality audio, video and data	Dynamic information access, wearable devices	Dynamic information access, wearable devices with AI capabilities
Multiple Access	CDMA	CDMA	CDMA & BDMA
Core Network	Packet Network	Internet	Internet
Handoff	Horizontal	Horizontal & Vertical	Horizontal & Vertical

3.5. Fifth Generation (5G)

Fifth generation denotes the next major phase of mobile telecommunications standards beyond the current 4G/IMT-Advanced standard. 5G is also referred to as beyond 2020 mobile communications technologies. [23]

In reality, 5G does not exist yet but the future network next to 4G we say as 5G. We so far heard about only LTE advanced, which gives peak download speed of 1Gbps and upload speed of 512Mbps, but you cannot drain full capacity with your mobile device. [6] It is expected that 4G network will see its end in few years to come and 5G will be its successor. 5G network will not be only more speed but also capable of carrying huge data. This generation is expected to roll out in the year 2020. 5G might solve the problem of frequency licensing and spectrum management issues. 5G terminals might have software-defined radios; also it might have different modulation schemes and error control schemes. It might also provide hundreds of channel without streaming.

4. Cell Phone Physics

An electronic telecommunication device often referred to as cellular phone or cell phone. Mobile phone connects to wireless communication network through radio wave or satellite transmissions. Most mobile phones provide voice communication, short message service (SMS), multimedia message service (MMS), and a newer phone may also provide internet services such as Web browsing and email.

A cell phone requires a subscription to a service provider and requires either a prepaid or monthly bill setup. Generally, they have more functions than traditional landlines and need to be charged after a period of time. [23] The most interesting thing about cell phone is that it's really a radio. Before cell phones people who needed mobile communication ability installed radio telephone in their cars. In the radio telephone system, there was one central antenna tower per city, and perhaps 25 channels available on the tower. The cellular phone system divides the area of a city into small cells. This allows extensive frequency reuse across a city, so that millions of people can use cell phone simultaneously. [9]

4.1. How Cell Phone Works

Imagine calling a friend on the side of the town. As you chat away, your phone converts your voice into an electrical signal, which is then transmitted as radio waves and converted back into sound by your friend's phone. A basic mobile phone is therefore little more than a combined radio transmitter and radio receiver, quite similar to a walkie-talkie or CB radio. In order to remain portal, mobile phones need to have relatively compact antennas and use a small amount of power. The cellular network divide up land into a patch work of "cells"- hexagonal areas of land each equipped with their own phone mast (also called the base station). This allows you to talk to your friends regardless of how far away your friends are. The huge phone masts pick up the weak signal from your phone and relay it onwards to another phone mast nearer to your friend. And if you're on the move while you talk, your phone switches masts as you go without interrupting your cell [21].

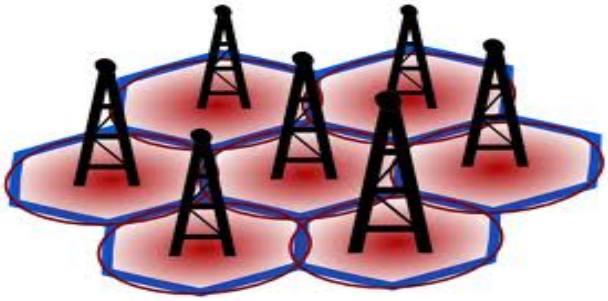

Figure 2. Cell network (source: www.google.com)

4.2. The Parts of Cell Phone

If you take cell phone apart, you find out that it contains just few individual parts, such as, an antenna, a liquid crystal display (LCD), a keyboard, a microphone, a speaker, and a battery.

Inside the phone there is a circuit board. The circuit board is the heart of the system. The computer chips on the circuit board would consist of three divisions. First, the analog-to-digital and digital-to-analog conversation chips which translate the out- going audio signal from analog to digital and the incoming signal from digital back to analog. It can process millions of calculations per seconds in order too compress and decompress the voice stream.

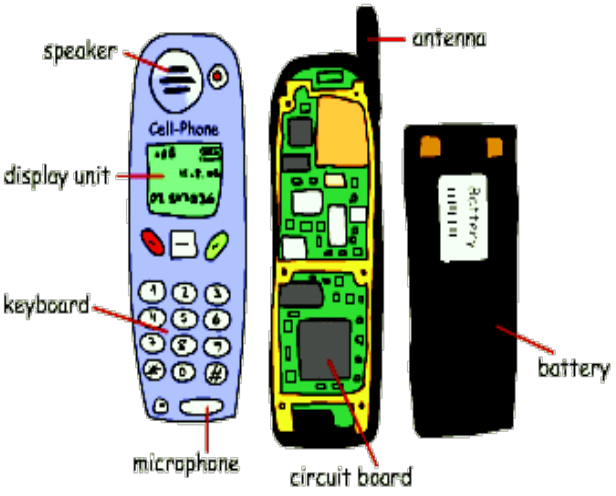

Figure 8. Parts of cell phone (source: www.google.com)

The second division is where the digital signal processor (DSP) is located. In this division, you would discover that the DSP is a highly customized processor designed to perform signal manipulation calculations at high speed. Then the third division is the microprocessor. This handles all the main functions for the key board and displays, deals with command and control signalling with the base station (cell tower) also coordinates the rest of the functions on the

board. The read only memory (ROM) and flash memory chips provide storage for the phone's operating system and customized features, such as phone directory. The radio frequency (RF) and power section handles power management and recharging, and also deals with the hundreds of FM channel. Lastly, the RF amplifiers handle signal travelling to and from the antenna. [19]

5. How Cell Phone Changed the World

The first major change that cell phone brought was that you can contact anyone everywhere at any time. Before cell phone, if a person was not at home it was very difficult to contact him/her. The introduction of cell phone has made communication easy in such a way that a wife can teach her husband how to cook just through phone call. Before cell phones, for most people, if you left your house, you could not be reached. This is no longer the case. Not only can your friends and family reach you whenever, but your job can as well. This has resulted in increased productivity. In Africa, most herdsmen can contact their families and friends no matter how far they take their cattle for grazing. And while there are people who think that this is a complete and utter breach of privacy and that the old way was better, we believe that this is a good thing as it allows friends and family to be able to communicate no matter where they are.

In addition, cell phone helps us to organize our daily activities more easily. For instance, business partners can make appointments through phone call, also business meetings could be held through conference phone call. Another exciting aspect is that plans could be changed by the use of cell phone; when you plan to meet a friend at a particular time and something comes up so you cannot meet or you want to change the time you can just do that with a phone call.

Cell phone helps us to get easy access to knowledge; The Internet which was previously limited to a computer, then graced the laptop and now phones, has made spread of knowledge and information easy and quick. Now who needs the newspapers to know about what's happening in the world? Your cell phone is your most trusted and portable encyclopedia.

Now we hardly see writing of letters as people have joined the text message train; it will not be wrong to say that writing letters today has become an ancient practice. What people now do is to simply send texts or emails through their phones. In previous times, one would actually spend a day or two in structuring and completing a letter, then spend extra money on mailing it and finally waiting till the letter reaches the desired person. People from our generation will consider this as a strenuous activity.

Cell phones, especially Smart Phones have everything you need! You can listen to songs, read books, access news, social networking sites and play games - all on your phone. It has in fact changed our very ways of life. From paying your parking, food, shopping bills to credit card transactions, measuring temperature, checking the weather forecast to taking pictures and videos, painting, drawing, playing your favorite instrument virtually, all this and much more is what the capacity of that little gadget has.

Our cell phones have become essential source of spending downtown; Phones have practically become an essential source of spending time. When you have nothing to do or no one is with you, all you need is your phone to be your companion or the special unit you can do an activity with. Just pick up your phone and either listen to songs, watch movies, call up a friend, check your emails or your accounts, click photos, and play games. With all this and more why would one need anything else?

The phone numbers these days have become our personal identities; Companies, institutions, and organizations who once needed to take a customer's or a client's full address to communicate with them, now only need their phone numbers. They send greetings, invitations, meeting notifications and information directly on your phone. So, your mobile number is your identity.

The cell phone introduction to the world is a blessing in disguise. It's just like fire, it's a good but also a bad master. Below are the bad changes cell phone has brought to the world:

Cell phones have almost replaced the need to be around people. It's not that you don't want people around you, but that you want to be alone so that you can browse or listen to songs or play games on your phone. We no longer need company, as long as we have our phones with us.

A cultural shift has been observed in ethics, and the traditional ways followed. For example: talking while eating was considered as bad manners. However, today it has become a common habit because so much is dependent on cell phones that its untimely and unrestricted use has been accepted worldwide. Talking in a cinema hall or at a funeral was once considered as a disturbance, but today it is overlooked. Mobiles have also replaced the age-old tradition of sending invites by an email or a text message.

A recent survey has shown that cell phones are shifting the young minds away from reality. This is because most of their time is spent in texting, chatting or talking on the phone, not allowing them to spend time with books, playing sports, with nature and with the real life.

Now, we don't need to go out to buy groceries to pay our bills, and to go out and play. All we need is a cell phone and we can get the groceries delivered at home, our bills are paid on the dial of a number and we now love to play soccer and pool on our phones. Cell phones have made our lives simpler, but have made us lazier too.

Not meeting your friends or family face to face is an easy possibility. Because you interact with them every day on Facebook. Both you and your loved ones are updated with whatever is happening in each other's life, what are you anyway going to talk about when you meet?

Excessive usage of cell phones can also contribute to the following diseases:

- Parkinson's
- Heart Diseases
- Brain Tumors
- Cancer
- Blood Pressure
- Headaches and Fatigue
- Weak Memory or Memory Loss Problem
- Bad Posture

6. Conclusions

Gone are the days when people have no cell phones and communication among friends, families and business partners was a nightmare. As time passed, technology improved and cell phone became very common that everyone use their cell phones than the previous landline. The introduction of cell phone has made communication easy in such a way that a wife can teach her husband how to cook just through phone call. Cell phones have changed our world and they will keep on changing it for years to come

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REFERENCES

[1] Jamie Brown. (2009). Cell phone history: Technology and innovation over the years. Retrieved at: http://www.voices.yahoo.com. Accessed: 16th April, 2014.

[2] China Mobile to set up world's largest 4G network. Retrieved at: www.zdnet.com/cn/china. Accessed: 17th April, 2014.

[3] Maxwell R. (2013). 1G. 2G, 3G, and 4G: The evolution of wireless generations. Retrieved at: www.phonearena.com. Accessed: 17th April, 2014.

[4] "ITU releases latest global technology development figures" Retrieved at: www.Umtsworld.com. Accessed: 29th February, 2014.

[5] Understanding 4G network. Retrieved at: http://www.4gamericas.org. Accessed: 20th April, 2014.

[6] Saurabh Patel, Malhar C. Kinjal K. (2012). 5G: Future mobile technology-vision 2020. International Journal of Computer Application (0975 – 8887). Vol.54-No 17.

[7] What is 2G technology/second generation wireless technology/digital radio signals. Retrieved at: www.Mechanicalenginneringblog.com. Accessed: 18th April, 2014.

[8] "Global mobile statistics 2012 part A: Mobile subscription; handset market share; mobile operations". Mobithinking.9th march, 2014.

[9] Why a cell phone is called a cell phone? Retrieved @ http://www.eletronics.howstuffworks.com/question582.htm. Accessed: 21st April, 2014.

[10] Jaceson Maughan. (2014). "A brief history of cell phones". Retrieved @ http://www.life123.com. Accessed: 16th April, 2014

[11] 3G (third generation of mobile telephony). Retrieved from: http://www.searchtelecom.techtarget.com/definition/3G. Accessed: 19th April, 2014.

[12] Kenneth J. Green, "Cell phone technology and the challenge of absent presence". Retrieved from: www.swarthmore.edu. Accessed: 15th April, 2014.

[13] Rahul G. (2011). Mobile generations 1G to 4G. Retrieved from: www.coolpctips.com. Accessed: 17th April, 2014.

[14] Chanel, An." What is the history of cell phone?" Retrieved from: http://www.cellphone.yoexpert.com. Accessed: 16th April, 2014.

[15] www.myjoyonline.com/business/2013/october 9/first 4G network rolled in Ghana.

[16] The evolution of cell phone design between 1983 to 2009. Retrieved from: http://www.webdesignerdeport.com. Accessed: 16th April, 2014.

[17] Marshall B., Jeff T., Julia Layton. How cell phones work. Retrieved from: http://www.electronics.howstuffworks.com. Accessed: 18th April, 2014.

[18] "Five major moments in cell phone history". www.cbc.ca/news/technology. Accessed: 16th April, 2014.

[19] Carolyn N. Kinder. (2007). the physics of cell phones. Yale-New Haven Teachers Institute. www.yale.edu. Accessed: 20th April, 2014.

[20] History of mobile phone: http://www.ieeemacau.ece.umac.com. Accessed: 17th April, 2014.

[21] How does mobile phone work? www.physics.org. Accessed: 22nd April, 2014.

[22] Generations of wireless network: 1G, 2G, 3G & 4G- mobile company. http:www.sites.google.com. 18th April, 2014.

[23] Cell phone definition.http://www.businessdictionarymary.com. Accessed: 20th April, 2014.

[24] 3G technology. Department of computer science & Information technology. http://www.itminda.edu. Accessed: 20th April, 2014.

[25] 2G, 3G, 4G, 4GLTE- what are they? http://www.whatsag.com. Accessed: 20th April, 2014.

[26] What is 4G cell phone technology? http://www.ask.com. Accessed: 20th April, 2014.

[27] What is 3G? http://www.uswitch.com/broadband/guides.

Accessed: 20th April, 2014.

[28] Saylor, Michael (2012). The Mobile Wave: How Mobile Intelligence Will Change Everything. Perseus Books/ Vanguard Press.p. 5. ISBN 978-1593157203.

[29] http://www.pongcase.com/blog/cell-phones-work"how do cell phones work" by Rong Wang, PhD

[30] Cooper, G. (2000) the Mutable Mobile: Social Theory in the Wireless World. Paper presented at the 'Wireless World' workshop, University of Surrey, April 7th.