

4G Network Technology: Challenges and Advantages for consumers

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Abstract:

The internet speed is crucial worldwide for users and the use of convenient and adaptability wireless internet is what needed for customers and businesses. Today, what matter for consumers are the better services from services providers with affordable cost. 4G/LTE internet came as the solution of what shown in 3G as the challenges, however until today 4G/LTE still needs additional features to improve the QoS. For past history of networks from first generation 1G to 3G, there was undoubted evolution and development and nowadays new generation called 4G starting to have an impact for consumers especially those who need internet in their businesses. This paper presents what community think about the use of 4G/LTE network and further discussed common facing challenges and advantages while customers using 4G Networks. We evaluated the main reasons there are still existing a big number of people who are still using 3G networks and what they use for 3G and 4G networks discussed in this paper. The findings showed 3G networks services still needed by many than 4G networks due to lower coverage of 4G/LTE. Internet coverage issue on 4G/LTE can be resolved by increased the coverage areas especial in rural by building new Base stations and towers to facilitate internet connectivity for remote areas with strong signal. The policy makers have to follow the implementation of those towers and be sure that they cover all the surfaces to produce good QoS for customers.

Keywords—LTE 2nd Generation (2G), 3rd Generation (3G), 4th Generation (4G) Advantages and Challenges, 4G LTE, Quality of Services (QoS)

I. INTRODUCTION

Wireless networks showed the evolution in telecommunication industry and it is very crucial and essential to facilitate businesses and the country's economy. Before the introduction of 4G

use there were the first Generation (1G) to fourth Generation of communication standards in mobile (4G) where the evolution in network technologies where started to impact the society ([1],[2]). The 1G was first settled in mid-80s in the United States and it was unable to serve in many services and

considered analogue and used for voice calls and it was the motivation to jump to new generation after improvement where the advanced mobile phone started and early 90s. The 2G was designed with technology of General Packet Radio Service (GPRS) and to work with code Division Multiple Access (CDMA) where these technologies allowed users to handle unlimited calls, sending amount of data using GPRS protocol and became the major feature in Global System for Mobile communication (GSM) and 3G born to increase the capacity in and optimum system for broadband data access ([3],[4],[5]). The 3G network is the third Generation of networks and internet which is based on the Mobile phone communication standard and allowing wide area wireless voice telephone, video calls, and wireless data (e.g. internet access) and the around 2001, the 3G networks were developed primarily to provide higher data rates than what the 2G networks offered before because 2G provides 170 kbps while 3G speed can reach to 42Mbps while downloading ([3],[6]). Today, 2G and 3G are both needed by customers due to the services they provide and there is no fact that one among them will be forgotten because 2G still in use in many areas in the world and main function is about the transmission of information through voice calls whereas the 3G offers all information related to data such as images and video ([3]). The society has been experienced to use the previous generations and technology continue to evolve and several

technologies were developed and upgraded to new technologies which could provide good and affordable services with lower cost. In this way, WiMAX based on IEEE 802.16 standards and 4G Long Term Evolution (LTE) and as well 4G Advanced developed to meet almost the standards of 4G ([1-2],[7]). Meanwhile there is no exact standards for 4G implementation and at glance WiMAX and LTE technologies standards referred as Pre-4G even if most companies brought these technologies to their customers as pure 4G which is not ([2], [8-9]). The society is moving from wired technology to wireless where they think it is the solution for the flaws of the previous mobile telecommunication industries [10]. This research paper focus on the how and what society think about 4G adoption and what the advantages and drawbacks they see on the 4G Networks adoption.

II. LITERATURE REVIEW

This part explores the second data from previous research studies about 2G and 3G and 4G/LTE as the major subject of this research paper.

A. Overview of 2G and 3G Networks

The current technologies of 2G and 3G have brought the clear vision to the scientists and engineers to rethink how new technology can be upgraded to resolve the past issues happened in 2G and 3G [3]. 2G networks are suitable for calls and texts only and around 2003 and 3G came with

addition features and it has ability to allow calls, text and internet accessibility [3]. The 3G system uses Code Division Multiple Access and Wide Band Code Division Multiple Access and it can produce good quality and high data transmission when it set up or it can be integrated as IP based technology [8]. International Telecommunication Union (ITU) have determined that 3G would be able to provide high speed data transmission than what 2G could offer [7]. The 2G network offered the long-distance coverage up to 10km and with lower frequency and due to its availability and the one which came first allows its availability in many corners as its technologies were expanding before the introduction of 3G [3]. Meanwhile, in every side as seen in the phone the strong signal of 2G than 3G when the device has ability to access both Generations (2G and 3G) just because there are numerous towers that currently provided voice calls before introduction of internet and 3G have additions features not available in 2G and it is based on the Mobile Phone Communication Standard and allowing wide area wireless voice telephone, video calls and wireless data. In all utmost side of technology, 3G is built under inside 2G network technologies because the engineers have developed 3G based on the current technologies of 2G [2]. Beside that 3G requires high frequencies than 2G to operates and customers must experience slower internet due that 3G still need additional towers to facilitate far customers live from the current

premises towers which provided 2G networks. All previous technologies have been upgraded with additional features from 1G to 3G and developed to meet customers' needs with high speed internet and affordable bandwidth price ([2],[11]). Nowadays customers need to have ubiquitous mobile communications services which could serve in their daily activities. Even if 3G were upgraded, customers still experienced faults in the use of previous generations like latency, slow speed of internet, and so forth and there is no doubt that 4G is at hand to resolve the previous issues available in 3G Networks.

B. The naissance of 4G Networks

Certainly, there is always an idea of upgrading to new technology which can produce addition features than the previous technologies. Because 3G network was unable to handle the increased data consumption, 4G networks born with an idea of creating solution to what was incapable in 3G [12]. Engineers from ITU Radiocommunication sector (ITU-R) and Institute of Electrical and Electronics Engineers (IEEE) always forced to provide 4G standards in 2008. The engineers from ITU developed several standards and spectrum allocations were set that the previous generations have been followed ([1-2],[7]). The 4G networks developed for mobile phone communications standards to provide higher internet access than what provided by 3G networks [8]. Objective of 4G is that the internet speed would be exceed than what

3G is currently providing. The internet is considered to be 4G technology if it can provide the internet speed up to 100Mbps for mobile user and 1Gbps for immobile user ([8],[13]). For its installation, there is costly at the first time but it can use the same infrastructures with 3GPP it is only need to upgrade the system and adding addition antenna with 4G components to the current 3G towers. The 4th Generation of wireless internet is a mast to resolve the current issues based on the slower internet and latency ([1],[9]). To have full advantage of 4G would require that devices designed to support 4G network technology and that's why some devices (phones, tablets,..) cannot supported because most of devices not built to handle 4G network [14]. Today, few electronics devices have built with capability to support 4G Networks and the numbers will continue enormously to the market in near future.

C. The LTE Technologies

Previous research studies showed that there was no technology that reached to the standards of original 4G which said to provide 1Gbps for fixed user and up to 100Mbps for mobile user [13]. LTE stands by Long Term Evolution and it was designed by the 3rd Generation Partnership Project (3GPP) group program and this was advertised as 4G LTE by vendors to their services subscribers. It was not to replace the current mobile technologies and it does not support full IP based network [11]. LTE is similar to the S series of iPhones and it can be

called 3G-S. Even though it was an improvement over 3G not enough to be qualified as new generation because it is not providing the minimum standards set by ITU-R [14]. Ericsson demonstrated that LTE peak rates can reach to 150Mbps and this put LTE to be used in place of 4G [13]. LTE technology is based on network technologies like GSM/EDGE and UMTS/HSPA and uses Multi carrier CDMA or OFDM (Orthogonal Frequency Division Multiplexing ([9],[15]). It supports all phones which are multiband [11]. 4G uses packet switching networks for voice calls and data and there is in improvement to resolve voice over LTE (VoLTE).

D. Challenges on 4G LTE Services

The most common challenges for Telecommunication companies are based on the lack of enough coverage because the challenges in spectrum allocation arose for deploying new bands and when it is necessary to increased additional spectrum the revenues will be also increased [16]. The little coverage in the country would be required addition cost for operators to build new additional base stations to resolve coverage challenges. 4G mostly facing challenge is how it can provide services to non-IP-based and IP-based devices together and this mechanism seems really tough and could rise the QoS problem for consumers ([5], [16-17]). Because the LTE need to upgrade software and hardware to the towers, operators could choose the for

investments and this cause the delay of LTE penetration in the country. According to RURA (2014) 20 % of the population was active internet users by March 2014. Rwanda Utilities Regulatory Agency (RURA) is in charge of evaluating end to end service quality consumers perspective on from 2G to 4G voice and data services and it reported that 3G is available for population of 92% coverage whereas LTE at 29% in June 2016 ([5],[19]). The operators mostly faced with problem of the range of spectrum bands to support and they choose what is priority between supporting lower frequency or high frequency band [16]. Because lower frequency spectrums are more affordable to build and their signals can penetrate for long distance whereas higher frequency spectrums need several base stations (which is costly) to cover the same distance but it is covering big populations areas than lower frequency and it is in this way it is suitable for its capability to manage heavy data volumes due to their larger bandwidth ([16], [20]). 4G LTE requires building of new radio access technology and core network which would increase additional cost for implementation and this is the challenge for operators or telecommunications companies ([5],[11],[20]). Once the operators increase the cost for consumers because they invest to new technology or upgrade from 3G to 4G LTE, the number of consumers could be reduced because some of them would lack ability to pay and the common solution is to change how they pay the

data services and let consumers pay what they consume rather than monthly paying as usually. Only multiband devices are able to use 4G LTE to roam internationally in all countries where it is supported and for data roaming based on the current worldwide spectrum usage, device needs to support at least 15 bands ([20],[21]).

E. Advantages of 4G / LTE

4G LTE designed from upgrading 3G Networks to providing affordable services for consumers with lower cost than what they have before. With its high frequency, single application can serve many consumers at once to gain high quality voice and data sharing. With its high-speed internet ([20],[22]). It can facilitate online television streaming and video conferencing based on its capability of high bandwidth signal and it can take short time to reconstruct as it can use current infrastructures of 3G and it only needs to upgrade the infrastructures from 3G to 4G. LTE has lower latency or response time when you compare to 3G Networks and 4G LTE is compatible with other technologies for radio access ([10],[20],[22]).

F. Customer's expectations from Vendors

What customers need is the good quality of services provided by Telecommunication companies and ISPs which is to bring high quality data voice and to access high speed internet for download and upload with affordable price ([5], [20],[22]).

Generally, the mobile data services such as GPRS and Enhanced Data rates for GSM Evolution (EDGE) providing at a speed of 56 kbps for the conventional modems and a speed of 144 kbps for the ISDN lines and the 3G born to increase the internet speed of 2Mbps both for downlink and uplink and it designed to work with IP based and in mobile condition to 384 kbps ([9],[11]). The use of 4G LTE continued to expand in Africa and several countries adopted 4G LTE to serve their people. According to [23] in 2018, Tunisia has the fastest mobile internet in Africa, the fastest average mobile download speed in Africa was 22.42 Mbps. African’s countries ranking in internet speed in 2018 where Tunisia has download speed of 19.21Mbps and 7.99Mbps because the increasing and upgraded to new technology and good ICT infrastructures. Table 1 showed the list of nine countries that have speed internet than others [23]. From 1996 to 2004 Rwandatel was only internet service provider under government and in 2008 Rwandatelintroduced 3G networks and due to different circumstances and it was lately sold by Airtel in 2012 [27]. There is a sharp increase from 2005 to 2010 with an 8.9% increase of Internet users between 2008 and 2010 and there was an increased for a period of five years ([24],[27]). Today several companies (MTN Rwanda, Airtel, Mango, Liquid Telecom, Korea Telecom Rwanda Network (KTRN), Africa Olleh Service) are providing internet 4G LTE networks.

Table 1: Internet speed ranking [23].

Country	Download Speed	Upload Speed
Tunisia	19.21 Mbps	7.99 Mbps
Egypt	15.89 Mbps	7.67 Mbps
Kenya	15.39 Mbps	7.82 Mbps
Cote d’Ivoire	14.71 Mbps	8.46 Mbps
Mauritius	13.24 Mbps	5.84 Mbps
Namibia	10.82 Mbps	8.19 Mbps
Nigeria	10.04 Mbps	4.2 Mbps
Tanzania	9.13 Mbps	4.94 Mbps
Uganda	8.55 Mbps	3.96 Mbps

Table 1 showed the list of nine countries that have speed internet than others [23]. In 2010, Rwandatel and MTN Rwanda introduced WiMAX technology to resolve an internet issue coverage and QoS. Rwandatel had 62% on its ADSL network and MTN had 35% with the IP services and wireline internet, VoIP and mobile data from 2010 innovations in wireless internet were increased [25]. Lately by 2014, 4G LTE was first launched in Rwanda by Olleh Rwanda Network later named Africa Olleh Services and the one of many objectives was about to let customers enjoy extremely fast download speeds and impact general lives and businesses and at that moment several Rwandans expressed their concerns that the 4G LTE was good but unaffordable for common man [26]. By 2016, Rwanda had a penetration rate of 3G of 92% of population coverage whereas LTE at 29% [19]. According to [19] the internet coverage still needed to be increased as shown in Table 2 where WiMAX can provide good services in the capital of Rwanda and outside Kigali.

Table 2:Technologies Comparison in Maximum Speeds today in Rwanda [19].

	EDGE/GPRS	WiMAX	3G+ or 4G LTE
Coverage	Most area in Rwanda	Mostly around in Kigali	Mostly around in Kigali
Maximum Speeds	175kbps	Up to 3Mbps	Up to 21Mbps

The MTN Rwanda was launched and started his services in Rwanda in 1998 after Rwandatel that started his services in 1996 and MTN Rwandacell started with 2G services and continued to integrated in the country until today. ICT sector attracted up to 45% of all investments in Rwanda and contribute 3% of the country’s GDP [26-27]. Tigo is no longer in Rwanda after Airtel bought all shares of Tigo including the towers just to have a wide coverage in Rwanda after MTN which have installed in Rwanda in 1998. Table 3 shows QoS parameters of different companies in Rwanda before Airtel bought all shares of Tigo because we no longer have Tigo in Rwanda but Airtel covered what belonged to Tigo [19]. Table 3 shows that LTE has different bands and the application throughput Downlink that average 9.1 Mbps for MTN and Round-trip time or latency of 55 milliseconds whereas 4G from Tigo has 51 milliseconds as what KTRN produced. Table 3 shows that 4G has lower latency compare to 3G.

Table 3: QoS Parameters

Quality of service parameters		MTN		TIGO		AIRTEL	KTRN
		2G/3G	4G	2G/3G	4G	2G/3G	4G
Application Throughput Downlink (Mbps/s)	Maximum	21.9	90.9	19.7	122.0	29.1	102.6
	Average	1.6	9.1	1.3	10.2	1.9	10.2
Round Trip Time (ms)	Median	375.0	55.0	230.0	51.0	299.0	52.0
LTE Coverage RSRP in dBm (Average)	LTE 800 MHz	-	-86.8	-	-85.1	-	-87.4
	LTE 1800 MHz	-	-83.8	-	-85.2	-	-83.3
LTE Quality RSRQ in dB (average)	LTE 800 MHz	-	-11.9	-	-11.9	-	-11.9
	LTE 1800 MHz	-	-9.7	-	-9.7	-	-9.8

III. METHODOLOGY

Based on research’s objectives empirical study has conducted and resulted on both qualitative and quantitative methods. Primary data were collected from the consumers or mobile users of data services either 3G or 4G/LTE and secondary data were collected from different papers, journals and websites. 110 questionnaires were used and 90 questionnaires received through e-mail and WhatsApp which indicate a response rate of 81.81 which is good response to this research. The main objectives of this research based on the study the challenges and opportunities (advantages) that customers meet while using 4G networks and why mostly people still use 3G Networks. Because 4G LTE is in use in the country in the place of real 4G, we use full name 4G LTE to let consumers aware of what we are talking for. To reach to research paper objectives, the four important questions were addressed to the responders so that they could help this research paper:

- ✚ what are the possible challenges you are experienced while using 4G/LTE Networks?
- ✚ What are the most advantages when you are using 4G/LTE Networks?
- ✚ Why are you still using 3G Networks?
- ✚ What are the most services you access while you are surfing with 3G or 4G internet?

IV. RESEARCH FINDINGS BASED ON THE OBJECTIVES

The first question is “*what are the possible challenges you are experienced while using 4G/LTE Networks?*” The seven questions were chosen to be responded by mobile users to find the main challenges they are facing while they are using 4G/4GLTE networks. Figure 1 shows how responders ranked the seven statements in questionnaire.

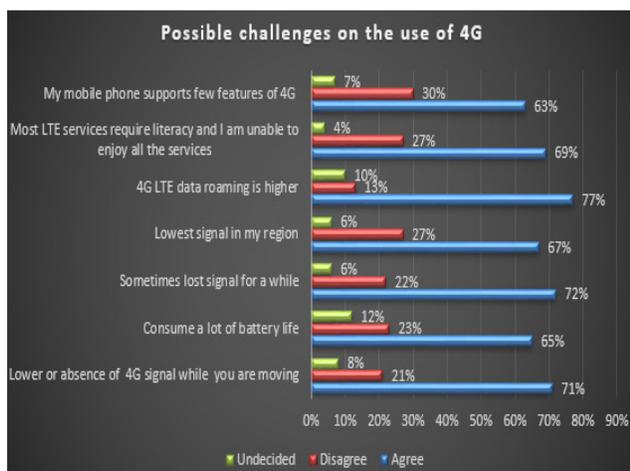


Figure 1: 4G Challenges ranked

The findings showed that lower or absence of 4G signal while moving from one region to another region and then it happens that signal may be disrupted and this was ranked at 71% as the challenge that met with the customers. Most responders claimed that 4G devices consume more

battery life than 3G and it can happen because devices with 4G need to accept more up to 10 bands ([20],[21]). The more devices captured more bands to process the signal ,the more it consumes a lot of energy battery life and also when a person is in the area where there is lower signal or absence of signal, it could use more battery life because mobile device will use much energy to find out the nearest tower to connect to which will require much more battery life and they ranked this statement to 65%. The findings showed that the sometimes 4G networks may lose the signal due to uncountable problem and ranked at 72% and the lowest signal in the area ranked at 67%. 4G LTE is still at infant sector most countries and coverage area sis still needed to be increased. The data roaming in 4G LTE is the challenge and it is ranked at 77% and literacy required in 4G devices ranked at 69%. Most people have really good 4G mobile devices but they only consume 5% of its services because they don’t have capacity in reading and writing to enjoy all the services and opportunities available on 4G mobile devices for example in Rwanda,the challenge named connecting Rwanda where hundreds of smart phones have been given to the citizen who mostly are unable to buy themselves those phones. Considering some of them would use these phones for only send and receiving calls because many them are old people who are uneducated and they are among of them who received those smart phones. The findings showed that some consumers’

mobile devices are unable to process full features of 4G networks services and ranked by responders at 63%. The second question is “What are the most advantages when you are using 4G/4G LTE Networks?” To answer this question, four questions were set in questionnaire to be answered by mobile users and the findings showed that 4G/LTE has lower latency compare to 3G.

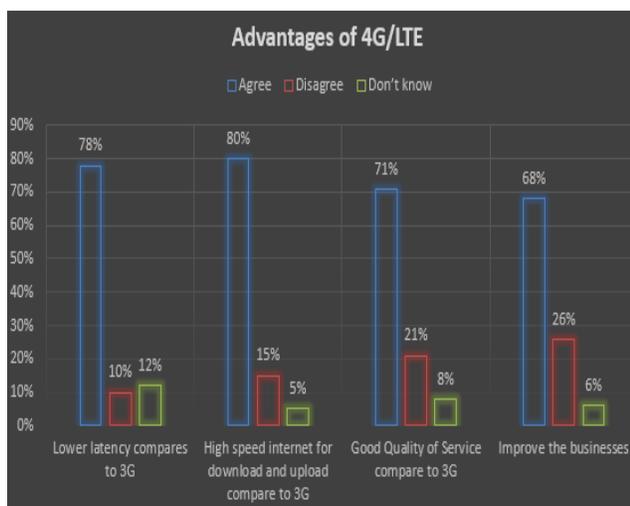


Figure 2: 4G/LTE Advantages

The findings showed that 4G/LTE has lower latency compares to 3G and this statement ranked at 78% and 4G/LTE has high speed internet for download and upload when compares to 3G networks and this statement ranked at 80%. The findings showed that 4G/LTE produces good QoS when it is in good condition compare to 3G and ranked at 71%. When it comes for business, the good internet is preferable and 4G/LTE was chosen as the best to provide internet that could improve business activities and they ranked this at 68%.

The third question is “Why are you still using 3G Networks?” To answer this question, we have set four questions in questionnaire to be answered by responders and the findings shown in Figure 3.

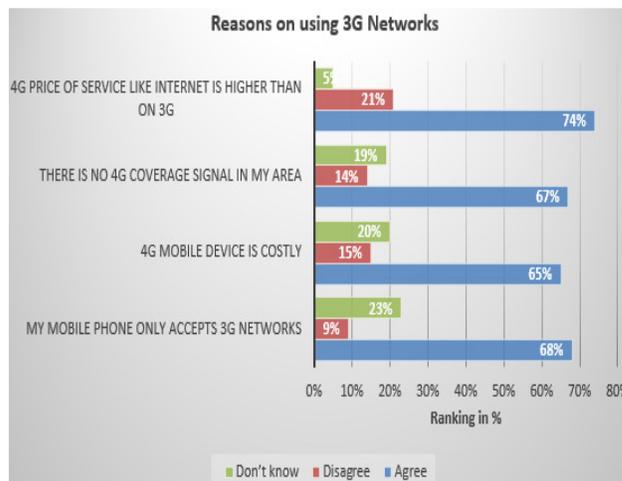


Figure 3: Reasons why still using 3G Networks

The findings showed that 4G services cost is higher than 3G services and this can be another reason why 74% still use the 3G networks. In most areas of the country, there should be lower signal or total absence of 4G coverage and this ranked at 67%. Because most 3G devices not accept 4G networks, the consumers who need to access 4G services will need to buy new devices which have capability to support 4G networksservices and most of these devices are costly and they ranked at 65%. The 3G networks came before 4G and it is available in many areas of the country than 4G coverage therefore, consumers would buy mobile phones and other devices with such technology and to change to 4G requires more effort and this ranked to 68% meant that many users are still having devices which accept only 3G Networks.The last question

in our research is *What are the most services you access while you are surfing with 3G or 4G internet?* To answer this question, four statement questions have set in questionnaire to be answered by responders. The objective of this question is to find out how society is engaged to use the services of 3G Networks and the services of 4G Networks and the findings showed that many people still using 3G for all mobile services and it can be reasonable that it effected by the lack of coverage area of 4G because even though the services providers said that there 4G Networks in whole country, the findings showed that most rural areas lack of strong signal of 4G/LTE.

3G and 4G/LTE attraction services for consumers

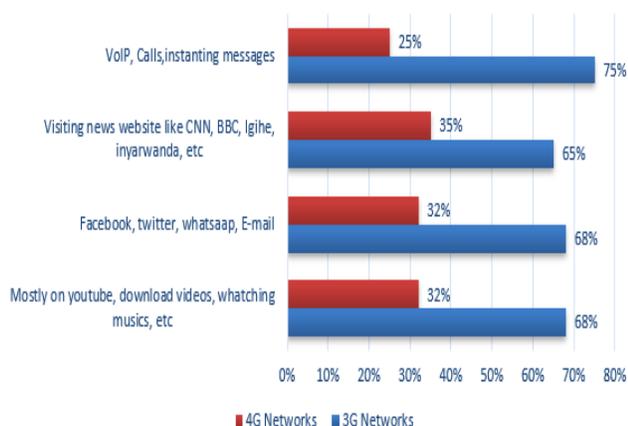


Figure 4: 3G and 4G/LTE attraction services for consumers

The findings showed that there is a big number of consumers which are still using the 3G services because of different reasons. The statement “Mostly on YouTube, download videos, watching music’s, etc” ranked by respondents to 68% for 3G networks

whereas 32% ranked for 4G. Obviously, this shows that many mobile users are having mobile devices which only accept 3G networks or it may be caused by either the cost of 4G services or it can be the cause of absence of coverage of 4G networks in their areas coverages. For example, considering the areas of Kayonza District, Rwinkwavu zone and neighbourhood’s areas there is no strong signal for 3G and 4G Networks in that area of the Eastern Province. The statement “Facebook, twitter, WhatsApp, e-mail” ranked at 68% for 3G whereas 32% is for 4G Networks. The statement “Visiting news website like CNN, BBC, Igihe, inyarwanda, etc” ranked at 65% for 3G whereas the services of 4G ranked at 35%. The statement “VoIP, Calls, instating messages” ranked at 75% for 3G networks whereas the services for 4G Networks ranked at 25%. It happens that the cause of using much more 3G services based on the its availability in many places than 4G/LTE.

V. CONCLUSION AND RECOMMENDATIONS

In the digital world, where technology evolves fast, what matter for consumers are the better services from services providers. 4G/LTE internet came as the solution of what shown in 3G as the challenges and until today 4G/LTE still needs additional features to improve QoS and that is 5G is at hand. Besides that, 4G/LTE has lower latency than 3G and it has high speed internet than 3G but the upcoming era of digital world needs more than

that. In this paper, we described the challenges which consumers are facing on 4G networks and we described the main advantages of 4G/LTE for consumers and we further discussed why there are still big number of mobile users which are still using 3G Networks. This paper also compares 3G and 4G in terms of how consumers are using their services. 4G or LTE can be meant the same in this paper because there was no real 4G to fulfil all requirements as mentioned in the literatures. This paper recommends the policy makers and services providers to resolve internet coverage challenges and lower signal networks in most rural areas. Internet coverage issue on 4G/LTE can be resolved by increasing the coverage areas especial in rural areas by building new base stations and towers to facilitate calling services and internet connectivity for remote areas to provide strong signal. The policy makers have to follow the implementation of those towers and be sure that they cover all the surfaces to produce good QoS for customers. There is a hope that new generation of 5G will put to end all technical challenges that happened in the previous generations especially in 3G and 4G and this 5G has already introduced by IT industries like Huawei, Samsung, ZTE, LG, Intel, Ericson, Nokia and Qualcomm and they projected that 5G would work in conjunction with 4G in the beginning.

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