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Contemporary Challenges Facing Mobile Networks Operators: A Comparative Survey Reflecting Migration from 3rd Generation to 4th Generation of Mobile Communications Between Tanzania and other Parts of the World

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***Abstract*—**Nowadays in Tanzania, some telecommucation companies also known as Mobile Network Operators (MNOs) are investing heavily in mobile broadband technologies including new base stations, higher-bandwidth tower connections and new backhaul solutions to meet emerging 4G/LTE requirements. Fourth generation wireless systems(4G) are likely to reach the consumer market in another few years and it comes with the promise that it will increased bandwidth, higher speeds ,greater interoperability across communication protocols, user friendly, innovative and secure applications. However, there are a lot of challenges which might lead to fading of the expected promises. Quantitative approach was used in this study whereby exhaustive literature review of thirteen (13) papers was conducted to compare and find out the relationship between the variables. Frequency and percentage were computed to find out the results. The findings show that mobile handset incompatibility, handoff issues, security and privacy issues, quality of service support problems, high billing to customers, complex infrastructure requirement, network spectrum problems, and mobile handset expenses are the challenges which might hinder MNOs from migrating from 3G to 4G.The study recommends that before deploying 4G network systems standardized environment which will facilitate the seamless accommodation of the newly technology and therefore entrenching the possibility of gaining from the technology the enticing advantages to both users' and providers.

Keywords— Mobile Networks Operators, 3G, 4G, Migration, Challenges, Tanzania

I. INTRODUCTION

Mobile telecom operators today are managing and running complex physical networks with a wide variety of network nodes, technologies and geographical span [1]. For example from the early analog mobile generation first generation (1G) to the last implemented third generation (3G) the paradigm has changed [2]. New generations have appeared in every ten years, since the first move from analog 1G in 1981 to analog 2G network. After that there was 3G multimedia support, spread spectrum transmission and 2011 all –IP Switched networks 4G [3]. Worldwide the last few years have witnessed a phenomenal growth in the wireless industry, both in terms of mobile technology and its generation. For example in developed countries of Europe, North America, China and South Korea adopted earlier the 3G standardized by 3rd Generation Partnership Project (3GPP). The third generation of cellular phones is based on a wideband CDMA standard developed within the auspices of the International Telecommunications Union [4]. In Japan the 3G standard network was launched by NTT DoCoMo in 2001 branded as FOMA and therefore releasing the test of W-CDMA, in Universal Mobile Telecommunications Systems (UMTS) Code Division Multiple Access (CDMA2000) & Time Division Synchronous Code Division Multiple Access (TD-SCDMA) and Frequency Division Multiple Access (FDMA) technologies. The 3G network also support the initialization of High-Speed Downlink Packet Access (HSDPA), High Speed Uplink Packet Access (HSUPA) and Multiple Input Multiple Output (MIMO) Systems [4].

In 3G services such audio and video streaming, several times higher data speed, video-conferencing, Web and WAP browsing at higher speeds, global CDMA 2000 Architecture positioning system (GPS) and IPTV (TV through the Internet) are enhanced [5]. Figure (1.0) shows the 3G architecture taking an example of CDMA 2000.

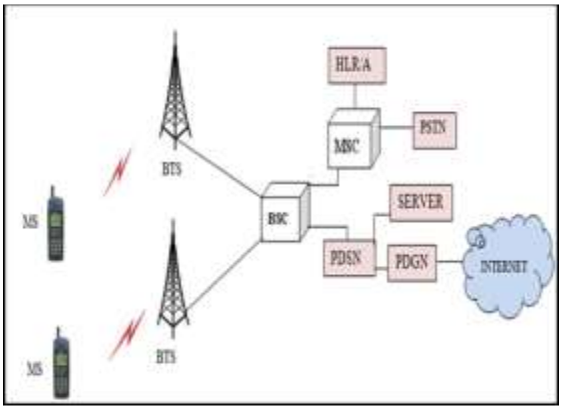

Figure 1. An example of 3rd Generation Architecture taking an example of CDMA. Source: Literature Review (2015).

Generally, the 3G standard is perhaps well known because of a massive expansion of the mobile communications market

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post-2G and advances of the consumer mobile phone. An especially notable development during this time is the smart phone (for example, the iPhone, and the Android family), combining the abilities of a PDA with a mobile phone, leading to widespread demand for mobile internet connectivity [4]. 3G has also introduced the term mobile broadband because its speed and capability make it a viable alternative for internet browsing, and USB Modems connecting to 3G networks are becoming increasingly common.

Since 2007, the fourth generation 4G of wireless cellular systems has been a topic of interest probably is because of the word "MAGIC" which is used to explain 4G wireless technology and which stands for Mobile multimedia, Anywhere, Global mobility solutions over, integrated wireless and Customized services [5]. The ongoing technology migration to higher speed networks is also facilitated by significant operator investments. According to GSMA report it shows that 4G networks are being rolled out at a faster pace than was the case with 3G (GSMA, 2014). The build out of LTE networks continued apace in 2014, with 335 networks having been deployed in 118 countries and reaching 26% of the world's population although there is a clear bias towards developed.

In December 2014, 4G coverage reached 90% of the population across developed markets and 15% in the developing world. North America has the world's highest 4G coverage at 97%, as well as the largest proportion of 4G connections over 40% against a global average of just over 7% e.g. in USA the Verizon Wireless, AT&T, T-Mobile and Sprint Corporation all use 4G LTE. In Latin America and Asia Pacific 4G will drive global coverage over the next five years.

Europe is now also seeing an increasing migration to 4G, with the majority of EU countries (24 out of 28) having had spectrum auctions and assigned the 800MHz band for example 2012, all of Italy's ISP have been offering or have plans to offer 4G services in some cities while in France the Orange launched the first 4G business plan in Marseille, Lyon, Lille and Nantes in the same year followed by the first-release Long Term Evolution (LTE) standard in Oslo Norway and Stockholm Sweden in 2009.

In Asia South Korea is one of the most advanced 4G markets with 100% population coverage and over two-thirds 4G adoption at the end of 2014 has matured to the point that it is seeing a greater number of users upgrade to unlimited plans. Thailand National Broadcasting & Telecommunications Commission (NBTC) has earmarked 1.8 GHz and 2.3 GHz spectrum for 4G services and in India Bharti Airtel launched India's first 4G service, using Time-division Long-Term Evolution (TD-LTET) technology, in Kolkata in (2012). Today the Bharti Airtel 4G services are available in Kolkata, Bangalore, Pune, Hyderabad, Visakhapatnam, Madurai and Chandigarh. From year 2012 there has technological migration in many countries of Asia including Indonesia, Pakistan, Philippines, and Kazakhstan etc.

In the developing world such as Sub-Saharan Africa Rwanda became the newest country to begin introducing 4G LTE services in its capital Kigali in 2014 whereby over 90% of Kigali has 4G Long Term Evolution (4G LTE) service coverage. While in Kenya Safaricom, the company with a 79% share of the market released its 4G network in 2014 for Nairobi and Mombasa. Furthermore, Algeria Télécom launched new fixed-wireless LTE high-speed Internet which offers 4G network for fixed home equipments. Generally the migration from 3G to 4G has been hassled by the new services offered in 4G such as high speed, high quality, high capacity and low cost services for example voice, multimedia and internet over IP [6].

4G is totally IP based technology with the capability of 100Mbps and 1Gbps speed for both indoor and outdoor and also expected to put together different presently existing and prospect wireless network technologies (e.g. OFDM, MC-CDMA, LAS-CDMA and Network- LMDS) to make sure that free movement and faultless roaming from one technology to another is achieved [7]. The technological difference between 3G and 4G is summarized in table (1.0) bellow:

Table1.Technological differences between 3G and 4G

Generation	Starts from	Data capacity	Technology	Standards	Multiplexing Technology	Switching	Service	Main network	Hand off	Frequency
3G	2001	384Kbps	Broad band/ IP technology FDD TDD	CDMA WCDMA UMTS CDMA 2000	CDMA	Packet & circuit	High speed /voice/ data/ video	Packet Network	Horizontal	1.6-2.5GHz
3.5G	2003	Mbps	GSM/3GPP	HSDPA HSUPA	CDMA	Packet	High speed /voice/ data/ video	GSM TDMA	Horizontal	1.6-2.5GHz
3.75	2003	30Mbps		1xEVDO	CDMA	Packet	High speed /internet /multi media			1.6-2.5GHz
4G [8].	2010	200Mbps To 1Gbps	LTE WiMaX	IP Broadband LA/WAN /PAN	MC-CDMA/ OFAM	Packet		Internet	Horizontal & Vertical	2-8GHz

Source: Literature Review (2016)

In Tanzania mobile network operators are trying to conquer the mobile market by offering very competitive mobile data plans The country has allowed a door open for wireless communications and mobile devices are increasing everyday with thousands of new subscribers join or shift network operators every day [8].

Up to June 2014 the number of mobile phone subscribers increased to 33 million people which is equivalent to 71% of the whole country [9]. Now, all mobile network providers in Tanzania supply mobile Internet access and even more wireless network operators with mobile Internet. The number of mobile phones companies' network providers has increased from one network provider in year 1998 to six namely Tigo, Vodacom, Airtel, Zantel, Sasatel, and TTCL.

In years 2014 Tanzania's government granted a licence to Vietnam-based telecoms operator Viettel to build a 3G network in the country looking to roll out a third-generation mobile network based on UMTS/W-CDMA technology has started its operation at the end of

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year 2015 with the brand name Halotel. Halotel already has a strong infrastructure comprising of 18,000 km of fibre optic cables and more than 2,500 base receivers in 26 regions of Tanzania s that has enabled 1,500 villages to be connected with (3G) internet [9].

Most of mobile network operators (MNOs) use 2G and 3G standards for mobile network services for example TTCL use CDMA in major cities, Airtel use GSM 900/1800, EDGE and GPRS for data and voice carrier while in year 2007 Vodacom Tanzania installed 3G network including HSDPA (High Speed Downlink Packet Access) technology which has enabled the company to have international roaming through partnerships with 288 live networks across 140 countries and territories such as India via BPL Cellular [9]. Furthermore, in 2015 TIGO Tanzania launched a new 4G Long Term Evolution (LTE) technology with 42Mbps speed which is 5 times faster than its current 3G technology, making it the fastest internet connection available in the country.

Before that the 4G LTE broadband network was only provided by Smile Communications Tanzania since 2012 and is commercially in Dar-es-Salaam. The 4G LTE technology is a standard for wireless communication of high-speed data and can accommodate more applications such as video conferencing, high definition content, video blogs, interactive games and video downloads on social networking sites. Airtel and Zantel, was in the process to launch 4G mobile broadband in Dar Es Salaam in 2013 and other major city centre's of Arusha, Mwanza, and Mbeya[9].

Despite the opportunities offered by 4G which range from individual customer, SMEs, public sector, the government and even to households level still the 2G and 3G remain the dominant network technologies in most areas of the country especially in rural areas. This situation create a debate on the issue known as "Technology leapfrogging" which refers to the adoption of advanced technology in an application area where immediate prior technology has not been adopted. The main challenges include the issues such as poor network coverage, cost of mobile devices which support 4G operations and battery life drain which is required by 4G services. This greatest impact of technology migration taking place in Tanzania needs preparation whereby to be able to use 4G mobile networks a new type of mobile terminals must be conceived and the terminals to be adopted must adapt seamless to multiple wireless networks, each with different protocols and technologies.

In order to implement the 4G the auto reconfiguration is also be needed so that terminals can adapt to the different services available which means that service providers must invest in new mobile network infrastructure before they can provide 4G the approach which is not yet completed in rural areas and in suburban. As a result, technology leapfrogging remains a controversial concept. This study explores the challenges encountered by MNOs in deploying 4G network systems in Tanzania and also suggesting the platform for all new technologies that have been deployed so far in order to harmonize the situation.

II. LITERATRUE REVIEW

A. Overview of Cellular Networks

Cellular communications worldwide has experienced a rapid growth in the past two decades [10]. Cellular communication is supported by an infrastructure called a cellular network, which integrates cellular phones into the Public Switched Telephone Network (PSTN) [11]. The essential elements of a Cellular Networks include mobile stations (MS) essentially enables a user to make communication. The MS is made up of two parts, the handset and Subscriber Identity Module (SIM), whose major function is to store data for both the operator and subscriber (Mishra, 2004). The overhaul coverage area of a cellular network is separated into numerous smaller areas, referred to as "CELL" and , each of is served by a base station (BS or BTS) which is planned and fixed to enable it be connected to the Mobile Telephone Switching Office (MTSO), also known as the Mobile Switching Center (MSC). The MTSO is in charge of a cluster of BSs and it is, in turn, connected to the PSTN (Zhang and Stojmenovic, 2005). For GSM network, BTS is then connected to MSC via the Base Station Controller (BSC). The BSC main function is usually to handle radio resource management and handovers of the calls from one BTS (or cell/sector) to another BTS equipped in it [10]. With the wireless link between the BTS and MS, MSs are able to communicate with wire line phones in the PSTN. Both BSs and MSs are equipped with a transceiver.

B. The 3rd Generation Mobile Communication System

The third generation (3G) cellular systems are based on wideband CDMA standard developed within the auspices of International Telecommunication Union [12]. The standard initially called International Mobile Telecommunications 2000 (IMT-2000) provides different data rates depending on mobility and location from 384Kbps for pedestrian use 144Kbps for vehicular use to 2 Mbps for indoor office use. The 3G of wireless is committed to provide reasonably speedy wireless communication to support more useful services such as data, video and multimedia as well as voice and offers next to future advances into the business/private wire-less technology, particularly in a field of mobile communications [6].

3G technologies make use of TDMA, CDMA and GSM. 3G use of value added services like mobile television, global positioning system(GPS) video conferencing and also supporting worldwide roaming and staying connected which the key service supported by GSM. As wireless usage continues to expand, existing systems of 3G are reaching limits whereby cells can be made smaller, permitting frequency reuse, but only to a point [13]. Generally the aim of the 3G is to allow for more coverage and growth with minimum investment in developing countries.

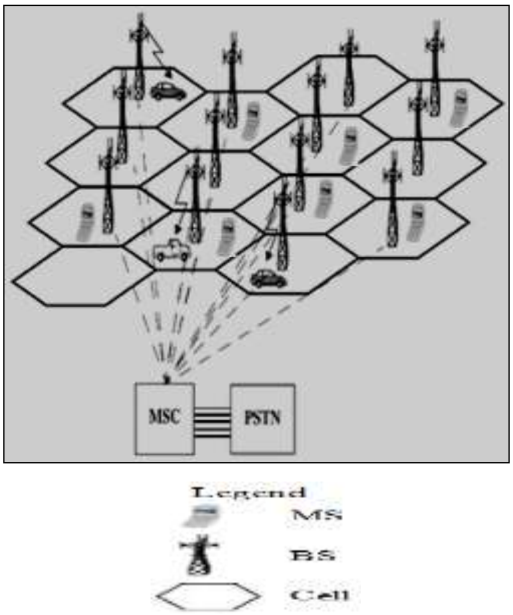

Figure 2. An Example of Typical Cellular Network

C. The 4th Generation Mobile Communication System

In telecommunications, 4G is the fourth generation of cellular wireless standards which is a successor to the 3G and 2G families of standards. In 2008, the ITU-R organization specified the IMT-Advanced (International Mobile Telecommunications Advanced) requirements for 4G standards, setting peak speed requirements for 4G service at 100 Mbit/s for high mobility communication (such as from trains and cars) and 1 Gbit/s for low mobility communication (such as pedestrians and stationary users). Worldwide, 4G mobile communication services started in 2010 but will become mass market in about 2014-15.

In contrast to 3G, the new 4G framework to be established will try to accomplish new levels of user experience and multi-service capacity by also integrating all the mobile technologies that exist (e.g. GSM - Global System for Mobile Communications, GPRS -General Packet Radio Service, IMT-2000-International Mobile Communications, Wi-Fi -Wireless Fidelity, Bluetooth [14]. The fundamental reason for the transition to the All-IP is to have a common platform for all the technologies that have been developed so far, and to harmonize with user expectations of the many services to be provided [15].

The main aim of 4G technology is to provide high speed, high quality, high capacity and low cost services for example voice, multimedia and IP internet. 4G system is expected to provide a comprehensive and secure all-IP based mobile broadband solution to laptop computer wireless modems, smart phones, and other mobile devices. Facilities such as ultra-broadband Internet access, IP telephony, gaming services, and streamed multimedia may be provided to users. The main radio access design parameters of this new system include OFDM (Orthogonal Frequency Division Multiplexing) waveforms in order to avoid the inter-symbol interference that typically limits the performance of high-speed systems, and Multiple-Input Multiple-Output (MIMO) techniques to boost the data rates.

D. Network Elements of 4th Generation Architecture

(i) User Equipment (EU)

UE is the device that the end user uses for communication. UE contains the Universal Subscriber Identity Module (USIM) which is often called Terminal Equipment (TE). USIM is used to identify and authenticate the user.

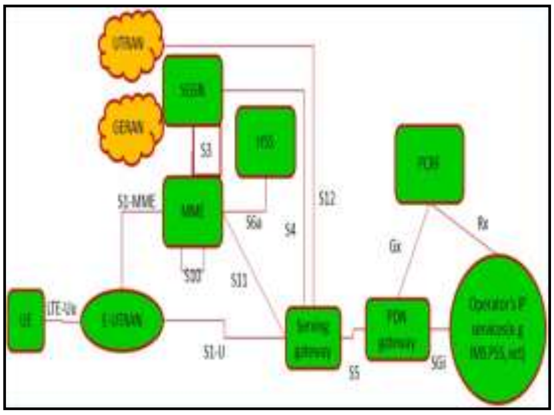

Figure 3. Network Elements of 4th Generation Architecture Source: Literature Review (2015)

(ii) E-UTRAN Node

It is the hardware which is connected to the mobile network to communicate with handsets (UE) whereby (UE) is connected to the E-UTRAN (LTE access network). There is evolved node which is the base station for LTE radio and which is responsible for radio interface transmission and reception. It is also responsible for Radio Resource Management, i.e. allocating requests based on requests, scheduling traffic.

(iii) Mobility Management Entity (MME)

The MME (for Mobility Management Entity) keeps track of the location (control plane) of all UEs in its service area. It also supports authentication, mobility and security services for E-UTRAN access. The MME is responsible for the tracking and the paging of UE in idle-mode. It is the termination point of the Non-Access Stratum (NAS).

(iv) Serving Gateway (S-GW)

The Serving GW is the point of interconnect between the radio-side and the EPC.S-GW is responsible for routing and forwarding packets to Packet Data Network Gateway (P-GW) and gathering accounting information of inter Node. S-GW acts as a local mobility anchor for the intra-LTE mobility (i.e. in case of handover between LTE and other 3GPP accesses).

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(v) Packet Data Network Gateway (P-GW)

The P-GW allocates the IP address to the UE and the UE uses that to communicate with other IP hosts in external networks. It serves as the interface between the LTE networks and other packet data networks.

(vi) GERAN

GERAN is an abbreviation for GSM EDGE Radio Access Network. GERAN is the radio part of GSM/EDGE together with the network that joins the base station.

(vii) Home Subscription Server (HSS)

Basically, the HSS (for Home Subscriber Server) is a database that contains user-related and subscriber-related information. It also provides support functions in mobility management, call and session setup, user authentication and access authorization. It is based on the pre-3GPP Release 4- Home Location Register (HLR) and Authentication Centre (AuC) [16].

(viii) Information Management System (IMS)

Information Management System (IMS) facilitates the storage, organization and retrieval of information.

(ix) Policy and Charging Resource ControlFunction (PCRF)

It is a software component that accesses subscriber database and other functions such as charging system. It makes decision on how to handle services in terms of QoS .It is the network element that is responsible for Policy and Charging Control (PCC).

E. Migration from 3G to 4G

After a decade of domination by GSM standard 2nd generation (2G) mobile phone networks, the world has embraced 3rd generation technology (3G) and is now starting to move towards 4G/LTE systems, even in remote and rural areas. From the early analog mobile generation (1G) to the last implemented third generation (3G) the paradigm has changed and today most countries are migrating from 2G, 3G to 4G. Terminal mobility will be a key factor to the success of 4G networks. The fact that 4G mobile networks intend to integrate almost every wireless standard already in use, enabling its simultaneous use and interconnection poses many questions not yet answered.

In addition, 4G networks, in opposition to the other mobile generations, must deal with vertical and horizontal handoffs, i.e., a 4G mobile client may move between different types of wireless networks (e.g. GSM and Wi-Fi) and between cells of the same wireless network (e.g. moving between adjacent GSM cells). Furthermore, many of the services available in this new mobile generation like videoconference have restrict time constraints and QoS needs that must not be perceptible affected by handoffs [13].With the adoption of 4G networks, the use of mobile data is expected to grow exponentially and overtake voice as the primary application being used on mobile communication devices today [17].

According to Shannon's Law, mobile 3G/4G technologies are evolving for more data capacity and this can be summarized as:

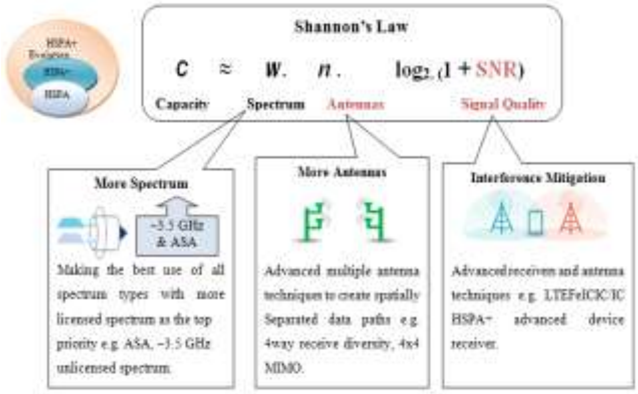

Figure 4. Shannon's Law mobile 3G/4G technologies

The formula shows the relationship between the capacity of the channel corresponding with the important components used in the communication systems, the symbol *W* represent the bandwidth of the channel in which the resources are allocated in term of spectrum, *n* represent the number of antennas in which the capacity of the signals increases as the number of antenna increases according to the MIMO technology which is more known in 3G and 4G and last *SNR* stand for signal-to-noise ratio of the communication signal to the Gaussian noise interference expressed as a linear power ratio.

As the mobile network operators migrates from current 3G systems to enhanced 3G (e.g., HSPA+, EV-DO Advanced) to 4G systems the network capacity is improving which also includes the higher-order modulation, advanced antenna systems, OFDMA, interference cancellation are being implemented. With MIMO, for example, the antennas are spaced far enough apart for independent transmissions to occur. In smaller handset devices, this may simply not be possible, especially at lower frequencies which translate to larger wavelengths and, hence, larger antenna separation.

Moreover if we referring the speed of 3G internet in few years we would have noticed the claimed top speeds rapidly increasing, starting around 3.6Mbps for the first series of mobile broadband 'sticks', to 7.2Mbps around 2007, to 21Mbps in 2008, to 42Mbps shortly after, and now 100Mbps with the 4G introduction in late 2011, this shows the demand of MNOs in order to satisfy the quality of the services to the mobile users.

F. Worldwide Selected Studies Addressing Technology Migration from 3G to 4G

In order to address the challenges faced through migration (technology leapfrogging) in Tanzania a number of studies were selected, and intensively reviewed worldwide. The variables were extracted accordingly as shown in (table 2).

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Table 2. Worldwide Selected Previous Studies Addressing the Challenges for Migration from 3G to 4G

Author/Researcher	**Major Findings**
D. U. Adokar, and P. J. Rajput, "Wireless Evolution with 4G Technologies," 2012.	(i) Mobile phone handset battery uses are hard to implement, (ii) Need for complicated hardware and software.
L. Xichun, A. Gani, R. Salleh, and O.Zakaria, "The future of mobile wireless communication networks," In *Communication Software and Networks, 2009. ICCSN'09. International Conference on*, pp. 554-557. IEEE, 2009.	(i) High security requirements, (ii) handover management issue, (iii) quality of service requirements, (iv) compatibility problems on how to integrate non-IP-based and IP-based devices, (v) high power consumption of mobile devices, (vi) complex infrastructure requirements,(vii) high service and billing.
A. M. Junaid, A. Farooq, and A. Shah., "Evolution and development towards 4th generation (4G) mobile communication systems," *Journal of American Science* 6, no. 12 (2010): 63-68.,*6*(12), 63-68.	(i) Mobile handsets expenses (ii) mobility management problems (iii) issues of spectrum, (iv) costs of infrastructure implementation.
B. Renuka, "3G to 4G core network migration," *Radisys White Paper* (2010). .	1) (i)Service providers require new infrastructure, (ii) increased risks of security intrusion and attacks (iii) demand on new platform hardware, (iv) problems of (QoS) support, (v) billing and policy enforcement.
C. Sonali, and V. Mane, "4G Wireless Networks Challenges and Benefits," *International Journal of Emerging Technology and Advanced Engineering* 3, no. 7 (2013): p307-p310.	(i) Mobile handsets incompatibility and high cost,(ii) handover problem e.g. high handover latency, and packet losses, (iii) security issues,(iv) problem of quality of services management (QoS), (v) high billing to customers.
O. Fagbohun, "Comparative studies on 3G, 4G and 5G wireless technology," *IOSR Journal of Electronics and Communication Engineering* 9, no. 3 (2014): 88-94.	(i) Poor network coverage, (ii) bad handset interconnectivity, (iii) problems of quality of service (QoS).
K.P. Malecha, and K.H. Wandra, "4G Wireless Networks: Opportunities and Challenges," In *India Conference (INDICON), 2009 Annual IEEE*, pp. 1-4. IEEE, 2009.	2) (i) Costs for 4G infrastructure installation, 3) (ii) inadequate security system for 4G networks, (iii) handoff mechanism problems,(iv) problems with billing systems management, (v) quality of service (QoS) support problems.
Kumar, R. M., A. N. Singh, V. Vasanthi, B. Bharati, and	(i) Mobility management, (ii) quality of services, (iii)

M. Hemalatha, "4G–fourth generation wireless systems requirements and technical challenges," *Journal of Theoretical and Applied Information Technology* 31, no. 1 (2011): 29-35.	interoperability, (iv) security and privacy issues, (v) spectrum problems, (vi) intelligent mobile devices requirements, (vii) networks coverage problems.
K., Kumaravel, "Comparative study of 3G and 4G in mobile technology," *IJCSI International Journal of Computer Science Issues* 8, no. 5 (2011): 3.	(i) High billing to spectrum, (ii) problem of quality of service support, (iii) handover problems.
N., Nikesh, "Voice quality control in packet switched wireless networks," PhD diss., Faculty of Engineering, University of the Witwatersrand, Johannesburg, 2012. 4)	(i) QoS service support,(ii) requirement for new infrastructure,(iii) mobility management problems.
A.K. Rathore, R. K. Chaurasia, R. Mishra, and H. Kumar, "Road Map and Challenges in 4G Wireless System," *J Elec Electron* 1, no. 2 (2012).	5) (i) Quality of service management problem, (ii) mobility issues, (iii) security issues.
B. Kalyani, R. Ludwig, P. Mogensen, V. Nandlall, V. Vucetic, B. Yi, and Z. Zvonar, "LTE part I: core network," *Communications Magazine, IEEE* 47, no. 2 (2009): 40-43.	(i) Congestion in the access network (*e.g.*, during peak times), (ii) problem of quality of service (QoS) support, (iv) complicated by gateway performance limitations, (v) compatibility problems of mobile handsets.
I.M. Kaleem, M. Bilal, I. Rasheed, and A. Sandhu, "4G Evolution and Multiplexing Techniques with solution to implementation challenges," In *Cyber-Enabled Distributed Computing and Knowledge Discovery (CyberC), 2012 International Conference on*, pp. 485-488. IEEE, 2012.	6) (i) Lack of seamless network connectivity, (ii) poor existing infrastructure, (iii) high cost for 4G infrastructure, (iv) staggeringly difficult 4G billing issues for customers

III. RESEARCH METHODOLOGY

This paper uses a quantitative approach in which descriptive analysis was adopted. An intensive literature review was conducted in order to extract the most frequent identified challenges which might lead to failure of migration from 3G to 4G networks systems among mobile network operators (MNO). The study extracted thirteen papers (13) selected worldwide to justify the extent regarding the challenges faced on migration from 3G to 4G network systems. The selection of these literatures was based on their relevance to the topic under study and up to date in which the literature was restricted within 5 current years (2011-2015). A sample size of 13 literatures was viewed adequate for statistical analysis since [18], [19] used a sample of 12 literatures to draw up the conclusion. Eight variables (8) variables were identified and analyzed descriptively and presented in tabular form in which frequencies and percentages were computed. These variables include :(i) mobile handsets incompatibility(ii) handover (handoff) problems (iii) security and privacy issues (iv) poor quality of services (QoS) (v) high billing to customers (vi) complex infrastructure requirements (vii) network spectrum problem (viii) mobile handsets expenses.

IV. Findings And Discussion

With the support of surveyed literatures the carried out, the most extracted challenges which might lead to failure of migrating from 3G to 4G among MNOs in Tanzania are presented in table 3.0. The sign (∞) indicates the variables which have been observed to be the critical challenges in the study.

Table 3: Predicted Technical Challenges Regarding Migration from 3G to 4G Among Mobile Network Operators in Tanzania

Researcher/Article	**Extracted variables(Challenges)**							
	(1) MHI	**(2) HP**	**(3) SPI**	**(4) QoSP**	**(5) HBCs**	**(6) CIR**	**(7) NSP**	**(8) MHE**
[20]						∞		∞
[21]	∞	∞	∞	∞	∞	∞		∞
[22]				∞		∞	∞	∞
[23]			∞	∞	∞	∞		
[24]	∞	∞			∞			∞
[25]	∞			∞			∞	
[26]		∞	∞		∞	∞		
[15]		∞		∞		∞		
1) [27]		∞	∞	∞		∞	∞	
2) [17]		∞		∞	∞			
3) [28]		∞	∞	∞				
4) [29]	∞			∞			∞	
5) [30]					∞	∞	∞	

Key: (1) MHI=Mobile handset incompatibility, (2) HP=Handover (handoff) problems, (3) SPI=Security and privacy issues,(4) QoSP= Quality of service support problem, (5) HBCs= High billing to customers, (6) CIR=Complex infrastructure requirement, (7) NSP= Network spectrum problems, (8) MHE=Mobile handset expense.

Table 4: Frequencies and Percentages of the Challenges for Migration from 3G to 4

Variables	**Frequency**	**Percentage (%)**
Mobile handset incompatibility	3	23.1
Handover (handoff) problems	7	58.3●●
Security and privacy issues	5	38.5
Quality of service support	9	69.2●●
High billing to customers	6	46.2
Complex infrastructure requirement	8	61.5●●
Network spectrum problems	5	38.5
Mobile handset expenses	4	30.8

Source: Analyzed from literature review 2015

Key:●●=Critical challenges.

V. Discussion

A. Quality of Service Management (QoSM)

The results in (table 4.0 and figure) indicate that 69.2% of the most MNOs face the problem of quality of service (QoS) when migrating from 3G to 4G. The rationale behind this is that when migrating from 3G to 4G there has been a problem of maintaining of quality of services (QoS) because many of the services available in this new mobile generation like videoconference have restrict time constraints which need not to be perceptible affected by handoffs. This problem is also addressed by [31] discovering the QoS problem to be caused by current version of wireless system which can be broadly classified into two categories which are: IP-based and non-IP based. This implies that with the development of 4G systems all networks will converge to a single transparent network.

This convergence creates a QoS challenges because wireless system will have different properties such as bit rates, channel, bandwidth allocation and hand off support. The important component of QoS assurance is resource allocation. Since 4G systems will need to accommodate different typed of users and application with different QoS needs the appropriate allocation of networks resources that will be quite challenging. For example LTE introduces challenges on how to satisfy the estab¬lished QoS expectations for circuit-switched mobile telephony and SMS for LTE-capable smartphones, while being served on the LTE network.

B. Handoff Management

The second critical challenge regarding migration from 3G to 4G is handover (handoff) problems also known as mobility a management problem which indicates 58.3% level. Handoff management is a key factor to the success of 4G networks.

In 4G systems mobility may occur in two ways: (i) by the user accessing the network using different devices at different place known as "Terminal Mobility" e.g. a user may access a video message using a desktop computer at work, a PDA on the road, and a laptop at home. It means that terminals must be able to provide wireless services anytime everywhere which implies that roaming between different networks must be automatic and transparent to the user. The most important aspect of terminal mobility is to provide the capability for seamless vertical handoff when the user move between different wireless systems as well as horizontal handoffs when the user move between cells in 4G.

In 4G systems, vertical handoff becomes a necessity due to the coverage nature of the networks. Vertical handoff is complicated because several networks are considered before vertical handoff can take place. The Protocol of choice for terminal mobility is mobile IPv6 which ensures a permanent 'home' IP address and a 'care-of' IP address. (ii) The second case is by a user moving from one place to place called as "Personal Mobility" which can be achieved by using the Session Initiation Protocol (SIP). SIP can help to locate one or more IP address where the user can receive multimedia streams so that the user can change the access device without notifying the callers. For example in figure 4, if the handover occurs between access networks (4) and (5) is because during roaming between two operators there was existing agreement otherwise no handover could be performed.

C. Complex Infrastructure Requirement

61.5% of the surveyed papers evidenced that complex infrastructure requirement it is necessary in case the MNOs have to migrate from 3G to 4G. The reason for complex infrastructure requirement in migration to 4G is that to integrate the existing non-IP-based and IP-based a clear and comprehensive QoS scheme for UMTS system infrastructure systems is required to provide QoS guarantee for end-to-end which is has proposed. In 4G the major problem is a need for high data rate (HDR) which is associated with more demand of bandwidth e.g. two additional frequency bands were identified in top of those frequency bands used currently by 2G and 3G mobile systems.

The two have different range e.g. one has a range of 5GHz and other is in the range of 60 GHz. In order to maintain the high data rates, smart antenna systems have been proposed for 4G wireless systems. It should be remembered that most of 2G and 3G network system infrastructure have no unified end-to-end architecture, which extends from the tower to the MSC to meet stringent 4G/LTE performance and scalability demands.

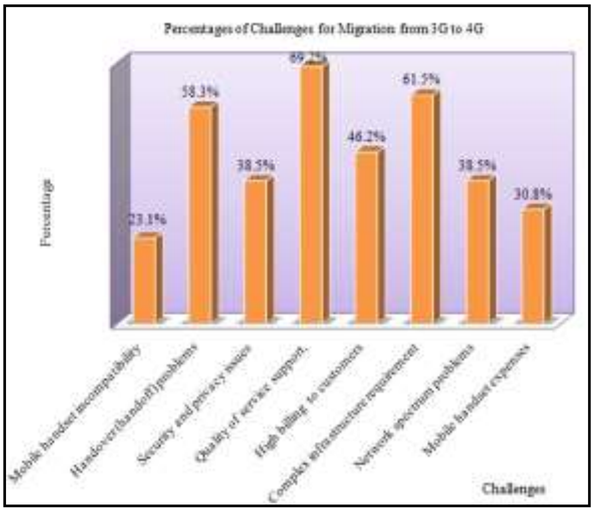

Figure 5. Percentages of Challenges for Migration from 3rd Generation to 4th Generation

RECOMMENDATION

In this paper analysis of challenges within the migration to 4G networks are studied and represented. It is generally accepted that 4G wireless systems which operate under LTE system has been developed as a successor of the UMTS radio network. The main features of LTE are increased bandwidth, support of multiple antennas at single base stations and the focus on packet switching (IP) protocol.4G network system will overcome the limitations of the existing wireless systems and will support new applications that are increasing in popularity to provide enhanced content management delivery using higher bandwidth, supporting of heterogeneous networks and providing efficiency of QoS.

However, it is recommended that before deploying 4G network systems to consumers several technical challenges have to resolve. The challenges which need to be first tackled regarding limited number of resources for Tanzania MNO companies include; (i) quality of service (QoS) which is the problem especially the assurance of quality of latency in existing wireless system in 3G, (ii) mobility management which will permit the contractual relationship during handover occurrence among two different access technologies or two dissimilar operators, (iii) complex infrastructure requirement which associated with.

In moving forward towards fulfilling the successfully deployment of 4G among MNOs in Tanzania the following are recommended. Firstly it should be remembered that, QoS assurance is important for real time traffics like Voice over IP (VoIP), online gaming, IP TV and video streaming etc. QoS enables network administrators to avoid network congestion and manage the network resources efficiently. Since the 3G packet core design is comprised of a diversity of mutually supporting components that in combination of the Universal Mobile Telecommunications System, the General Packet Radio Service (GPRS) Support Nodes (GSN), the Gateway GSN (GGSN) and the Serving GSN (SGSN) which all establish an interface between the radio system and fixed networks for packet-switched services, the reliable, stable and scalable performance of all of these is critical to ensure that service stability and quality is maintained.

Now in 4G networks has to be provided for voice as well as data assurance of quality of latency in existing wireless system in 3G in order support its current access technology to automatically handover to another technology seamlessly. There are some protocols designed to maintain the seamless communication of the users while moving or in other words to minimize the latency and packet loss of the ongoing communication session e.g. Mobile IPv6, Hierarchical MIPv6, Fast MIPv6 and some more. These protocols can help in improving the mobility management of mobile users. In order to support QoS to the mobile users the combination of mobility protocol Seamless Mobile IPv6 (SMIPv6) and Session Imitation Protocol (SIP) is proposed.

Secondly is mobility management: Mobility management is a very essential in 4G-Networks as it is mixed network which is more complex to handle. Mobility management in 4G can be done in different layers of the Open System Interconnection RM to include L3(network layer), L2 (link layer) and (L3 + L2) cross layer. In order to tackle mobility problem MNOs must implement innovative mobility management solutions in order to accommodate mobility between 3GPP (GSM, UMTS, and LTE) and non-3GPP radio access technologies, including CDMA, WiMAX and Wi-Fi. Therefore, a converged mobility and policy is recommended while migrating from 3G to 4G to maintain efficient service delivery over mixed 4G and 3G networks and providing differentiated services and applications.

The basis of this convergence is the use of an IETF-defined mobility management protocol such as Proxy Mobile IPv6 (PMIPv6). Administrative entities called Mobility Anchor Points (MAP) are added to border routers of each domain, while vertical handoffs between different radio access networks should take place transparent to the application layer. This can be achieved by setting up data streams on both radio access networks during handoff, synchronizing the two and then passing the data stream from the new radio access network to the application layer. For the case of complex infrastructure requirements, MNO must have many technology options for building out a 4G network accommodating infrastructure which is expected to provide much higher data rates, lower cost per transmitted bit, more flexible mobile terminals, and seamless connections to different networks. For example LTE needs a distributed architecture to improve network performance, resilience and scalability. With all packet-backhaul architecture use traffic (voice, data and control traffic, signaling, network management and synchronization data) are all carried over the same physical infrastructure. This approach combines voice, data and management traffic onto the same packet infrastructure which provides one pipe to the tower and hence supports the necessary security features, prioritization capabilities and protection schemes to allow various traffic types as well as traffic from multiple wireless operators to transit the same packet connection.

Conclusion

4G networks seem to be very promising generation of wireless communication that will change the people's life to wireless world. There are many striking attractive features proposed for 4G which ensures a very high data rate, global roaming etc. 4G is said to be applied in tele-medicine by supporting remote health monitoring of patients as well as supporting tele-geoprocessing applications, crisis managements and education.

However, we believe that future analysis can overcome these challenges and integrate new developed services to 4G networks creating them obtainable to everybody, anytime and everyplace especially in rural areas where the network has been unable to supply.

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