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5G Network Roll-Out and its Impact on the Current Existing 3G and 4G Based Systems – A Case Study of Zambia

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Abstract- This research paper investigates the deployment of 5G and the impacts it willbring about on the existing 3G and 4G Networks in Zambia. It further explores if internet service providers are managing to cope with sudden high demand and if it is driving them to hasten their deployment plan. The Research will implement Qualitative analysis methodology which will involve the identification and assessment of related case studies, which will include reports from Internet Service Providers, Network Operators, Regulators and other stakeholders, it will also include journals and research papers which were writtenby independent individuals and research organizations. The expected outcomes of this research will include a comprehensive understanding on the deployment of 5G and its effect on previous generation networks, an assessment of the challenges and opportunities for network operators. This research will present the results and provide the immediate proposed solutions.

Keywords:- *5G, Internet Speed, Connectivity speed, Mobile apps, Deployment.*

I. INTRODUCTION

5G is the fifth-generation mobile network. It is a standard that comes after 1G, 2G, 3G, and 4G networks globally. 5G technology is meant to bring about or deliver multi-Gbps peak data speeds, ultra-low latency, high reliability, massive network capacity, increased availability and a more uniform user experience to more users. High performance and improved efficiency empower new user experiences and connects industries [1]. The spectrum available for 5G as allocated by the Third Generation Partnership Project (3GPP), is subdivided into bands below 6GHz and above 6GHz (in this case in millimeter waves at 28GHz and 39GHz). 5G is expected to accommodate billions of devices leading to an exponential growth of number of devices connected as well as the volume of data traffic consumed [2]. With this demand internet service providers (ISPs) need to step up so as to meet the high demand.

The rest of the paper is arranged as follows: the next section discusses the related works on the deployment of 5G (III) discusses the impacts of 5G on the current existing 3G and4G, (IV) challenges being faced by ISPs withregards to 5G deployment, (V) proposed solutions, and finally (VI) conclusion.

II. RELATED WORKS ON 5G ROLLOUT

"Feasibility and challenges of 5G network deployment in least developed countries (LDC)" by A Rahman, S Arabi and R Rab. This research paper evaluates the possibility of implementing 5G networks in Less Developed Countries (LDCs). This study takes into account the major technical difficulties that LDCs are likely to face during the implementation process. It alsohighlights the ongoing security concerns associated with 5G networks and argues that LDCs may not possess the technological competence to handle many of these securityissues. The paper also discusses how many of the use cases for 5G networks may not be relevant in the context of LDCs, at least not at present.

"Challenges and Trends in 5G Deployment: A Nigerian Case Study" by Gbenga Salami, Nasir Faruk and Felix Ngobigha (2019). This paper addresses the global trends and challenges for the early 5G rollout with focus on the Nigeria market. It also provides solutions to guide Nigerian Mobile operator on pitfalls and barriers to entry, to allow smooth transitioning from 4G to 5G technology in Nigeria.

"A Survey on 4G-5G Dual Connectivity: Road to 5G Implementation" by Mamta Agiwal, Hyeyeon Kwon, Seungkeun Park and Hu Jin (2021). This paper discusses how network operators need to upgrade their networks to allow dual connectivity so as to meet the demands of their new subscribers while ensuring that their LTE subscribers requirements are not compromised as the transition to 5G takes place.

"Migration and Interworking between 4G and 5G" by Prakash Suthar, Vivek Agarwal and Anil Jangam. The main goal of this paper is to provide system architecture and methods of interworking and migration between 4G and 5G mobile technologies. It identifies different interworking scenarios, associated challenges, and addresses possible solutions.

III. IMPACTS OF 5G NETWORK ROLL-OUT ON PREVIOUS GENERATION NETWORKS

The arrival of 5G promises to revolutionize the way we communicate and access the internet, and it has the potential to transform industries such as healthcare, transportation, and entertainment. However, the roll-out of 5G networks is also expected to have significant impacts on previous generation networks such as 4G and 3G.

Firstly, the 5G network roll-out is likely to have a positive impact on 4G and 3G networks. With the deployment of 5G, the existing 4G and 3G networks will experience reduced congestion, resulting in faster data transfer rates and lower latency. This will lead to a more efficient use of the existing spectrum, making it possible to connect more devices to the network [3]. This will be beneficial for businesses and consumers who rely on 4G and 3G networks for their daily communication and internet access needs.

5G roll-out will, however, bring about some negative impacts on previous generation networks. One potential negative impact is that 5G networks may overshadow the existing 3G and 4G networks. As 5G networks become more widespread, consumers and businesses may shift to using 5G networks for their communication and internet access needs, leaving the older networks with less traffic [3]. This may lead to reduced revenues for internet service providers who have invested in 4G and 3G networks.

The roll-out of 5G may require putting up new or latest infrastructure such as antennas and base stations and these may require additional costs and resources on the part of internet service providers as well upgrading their networks to support 5G. This is another negative impact [4].

Another impact of 5G is on the availability of spectrum for 3G and 4G networks. As telecom operators deploy 5G networks, they may need to use some of the spectrum currently allocated to 4G and 3G networks. This may lead to reduced bandwidth for 3G and 4G networks, resulting in reduced data transfer rates and increased congestion [5].

IV. CHALLENGES FACED BY ISPs IN THE DEPLOYMENT OF 5G NETWORKS

Building of the necessary infrastructure needed for the deployment of the 5G network is one of the biggest challenges faced by ISPs. This is because 5G networks require a significant investment in needed new hardware, such as small cells and base stations, which have to be installed in densely populated areas. This will again require that operators work closely with local governments to secure permits and access to public spaces to install this infrastructure which can be expensive and time consuming[6].

Another challenge of 5G networks is the limited range of high frequency bands, these frequency bands are necessary for achieving the fastest speeds and lowest latencies. These high frequency bands, also known as millimeter wave (mmWave) spectrum, have a shorter range than lower frequency bands and are easily blocked by buildings and other obstacles. This means that ISPs must deploy a dense network of small cells to ensure coverage in urban areas, which can be costly and require significant planning [10][4].

With more devices connected to the network and more still connecting, there will be more data being transmitted and in turn an increase in risk of cyberattacks. Therefore, security is equally one of the notable challenges of 5G networks. 5G networks also rely on software defined networking and network function virtualization (replacing network appliance hardware with virtual machines to run networking software and processes), which is most likely to introduce new vulnerabilities that must be addressed. Operators must implement robust security protocols to protect against cyberattacks and ensure the integrity of the network [7].

5G networks have a potential for interference with other wireless technologies. As more devices are connected to the network and more data is transmitted, there is an increased risk of interference with other wireless technologies, such as Wi-Fi and Bluetooth. Operators/ISPs must ensure that their networks are designed to minimize interference with other wireless technologies and comply with regulatory requirements [8].

V. PROPOSED SOLUTIONS

Beamforming is a processing technique for signals that allows for directional transmission or reception and it has an important role in 5G networks particularly in the context of frequency bands above 6GHz. The spotty coverage of high frequency mmWaves can be mitigated by directional beam communication. With highly directional beams, fast changing channels and several small cells, this directional tracking may be the main way to realizing reliable mmWave 5G networks [3].

The Fifth Generation New Radio (5GNR) aims to achieve a peak data rate of 20 Gbps for downlink transmission under error-free conditions. To achieve higher data rates, a 5G cell can be combined with a Long-Term Evolution evolved Node Bs (LTE eNodeBs) at the radio access level, allowing for the peak data rates of both systems to be aggregated, which can improve network performance and user experience. This multi-link aggregation enhances both peak data rates and area spectral efficiency, which is particularly important during the early stages of 5G deployment [3].

Many LTE operators use commonly available frequency bands in the low and mid band range which are now being allocated for 5G frequency bands. However, since a significant number of users are currently utilizing LTE services, it is not

feasible to completely reassign LTE carriers for use in NR. Therefore, an effective spectrum sharing mechanism is necessary to enable 5G operation on existing low-frequency bands without disrupting end-users' experience on either LTE or 5G services [9].

There are several ways security concerns of 5G networks can be mitigated, the first line of defense is network security. Network operators should ensure that they have proper firewalls, intrusion detection and prevention systems, and encryption in place to protect against attacks. Strong authentication mechanisms can help prevent unauthorized access to the network. Multifactor authentication can be used to ensure that only authorized users can access the network. Regular security audits and penetration testing can help identify vulnerabilities and ensure that security measures are effective [11][6].

VI. CONCLUSION

This research has provided an understanding of the effects of 5G deployment on previous generation networks and an assessment of the challenges faced by network operators. This paper has highlighted several solutions onhow to mitigate impacts of 5G on previous generation networks and proposed ways on how solve the challenges faced by network operators.

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