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Internet Access Commercialization Viability in Federal Polytechnic Offa Using Starlink Satellite Connectivity

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ABSTRACT: This study uses Starlink satellite technology to examine the feasibility of commercialising broadband internet access at the Federal Polytechnic Offa. This study examines the current status of internet access at the institution, assesses the potential advantages of Starlink, and explores the financial effects of putting this satellite broadband solution into place in light of the growing demand for dependable internet connectivity in educational institutions. According to the results, Starlink offers a workable solution for expanding internet access, boosting institutional effectiveness and academic results.we measure the round-trip time (RTT) inflation, which is the difference between the maximum and least RTT observed during a speed test. The result demonstrated a significant increase in delay inflation under load, with Starlink experiencing RTTs rising by ≈2-4× to more than 400–500 ms while downloads were active.

KEYWORDS: Broadband, Educational access, Internet connectivity, Starlink, Satellite technology, Wireless communication.

I. INTRODUCTION

Reliable internet connectivity has become more and more in demand in recent years, especially in educational institutions like the Federal Polytechnic Offa where digital tools are necessary for efficient teaching and learning (Ali, 2020; Bojović, Bojović, Vujošević& Šuh,2020). The Federal Polytechnic Offa in Nigeria sometimes has serious issues with poor internet access, which makes it difficult to do research and provide instruction. Alternative broadband solutions are required since traditional broadband infrastructure is frequently insufficient in underserved and rural locations (Blackwater, 2020; Pipa, Landes& Swarzenski, 2023).

Against the above background, this research tends to first investigate the availability, affordability and market penetration of current broadband services in Africa. We assess the limitations and constraints of currently available ADSL and mobile 3G broadband technologies to determine if these technologies will be able to meet future demands for consumer broadband services in Africa. We then analyze current satellite television broadcast solutions and the synergies thereof with possible consumer broadband services. The technology study furthermore quantifies the potential advantages of using satellite technology to implement a mass consumer broadband service in Africa, based on the ubiquitous nature and rapid deployment capabilities of satellite access networks(del Portillo, Eiskowitz,Crawley& Cameron,2021; Oughton, 2023).

The purpose of this paper is to assess whether Starlink satellite technology can be commercialised to improve internet access at the Federal Polytechnic Offa.

II. LITERATURE REVIEW

A. Studies on Internet Use

The use of the internet draws users' eyes to the world's vastness around them. The internet gathers various types of data that college students and senior high school students use. Internet use will continue to grow if users are no longer denied accessibility. People's ability to access data sites such as social networking sites, online sports, and cybersex, according to recent data, is made possible by the internet (Flayelle et al., 2023).

Most students have internet access on their mobile phones because of the internet accessibility. Students will expand their intellectual horizons due to this. Laptop use and online resource accessibility are crucial for learners. It can be concluded that the internet is generally utilized for leisure activities instead of for instructional ones. Students are increasingly inclined to utilize the Internet. Still, they spend most of their time using it for non-academic activities such as email, gaming, and social networking. As a result, this led to setbacks in their academic plans (Amponsah, 2022). This explains the contradictory research findings on the influence of internet use on student academic progress. Students' top activities are chatting, followed by uploading and viewing multimedia videos, browsing the internet, using the internet to find knowledge for schoolwork, and searching for various websites such as sports, online news, games, and shopping online (Musa et al., 2023).

The demographic variables of students are assumed to impact internet use and academic performance as a result. A demographic comparison found that adult males were more commonly approved for internet use than females(Baloğlu, Şahin& Arpaci, 2020; Oka et al., 2021).

B. Review of Past Works on Internet Connectivity

The absence of information and communication technology (ICT) infrastructure in Sub-Saharan Africasupports the idea that the region's increased broadband infrastructure can stimulate internet usage. Consequently, the authors have offered insights into the factors influencing the adoption of the Internet in a country in sub-Saharan Africa. Based on a dataset of Nigerian homes, this study provides insights into the infrastructural, socioeconomic, and demographic factors that influence internet usage in Nigeria (Awad & Albaity, 2022; Owolabi et al., 2023). In Africa, the digital economy can be a real tool for reducing unemployment, inequality, and poverty. Nevertheless, the ICT sector's meagre investment hasn't produced the anticipated inclusive growth effect. Thus, the purpose of this research is to examine how ICT infrastructure affects inclusive growth in Africa. Based on inclusive growth analytics, data covering 46 African nations between 2000 and 2019 was analysed using the Blundell-Bond system generalised technique of moments estimator. The primary conclusion drawn from the empirical research is that ICT infrastructure, both generally and specifically across sub-regions within the continent, significantly and favourably influences inclusive growth in Africa. Investing more in ICT infrastructure typically results in an average 0.4%–0.7% boost in inclusive growth (Nchake & Shuaibu, 2022).

Instruction has historically been delivered through face-to-face encounters between instructors and students in classrooms. Online learning has been made possible by advances in digital devices and communications technology. It offers the potential to expand access to higher education while keeping costs down. Massive open online courses (MOOCs) are available to students for free if they have a laptop or smartphone and an internet connection. However, several obstacles prevent the benefits of online learning and the potential to expand education from always being realised. This study classifies socioeconomic, sociocultural, and IT infrastructure variables as barriers to online learning adoption in Nigeria. While several characteristics that impede online learning have been recognised in the past, the actuality and severity of these issues are not well-supported by empirical data. Since growing education means reaching a global audience, local contexts—like those in Nigeria and other poor nations—become crucial. Therefore, the goal of this work is to comprehend these difficulties, provide empirical support via a questionnaire survey, prioritise these difficulties, and provide remedies(Virani, Saini& Sharma, 2023).

For internet facilities to be implemented and integrated into schools, the resources need to be both accessible and available. This study set out to find out what internet resources were available to secondary school teachers, ascertain whether or not these resources are accessible to them, and look into how teachers' gender affects the availability of these resources in Ilorin's secondary schools. Only secondary school teachers in Ilorin, Nigeria, were included in the study's population; 251 respondents were chosen at random. The degree of online resources that male and female secondary school instructors could access for teaching did not significantly differ from one another. According to the study's findings, educators can use the internet's

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resources for advanced learning. To bring online services closer to instructors, it was suggested that Internet service providers (ISPs) be permitted to open facilities on campus (Onojah et al., 2021; Melinda, Anjani & Ridwan, 2023).

C. Review of Past Works on Starlink

Satellite-based Internet connectivity is starting to replace traditional fixed and wireless technologies with comparable throughputs and latencies thanks to new Low Earth Orbit satellite constellations like Starlink. We examine how users evaluate Starlink's performance in this research. Our results indicate that under idle or lightly loaded connections, latency stays low and does not change much (Michel, Trevisan, Giordano & Bonaventure, 2022). In comparison to another commercial Internet service provider that uses a geostationary satellite, Starlink offers quicker online surfing and a better TCP throughput. We also employ QUIC to evaluate performance under load and packet loss, avoiding interference from performance-improving proxies that are frequently used in satellite networks. According to our findings, there is a modest increase in packet loss and latency for both download and upload under load.

The proposed "mega constellation" of about 12,000 Starlink Internet satellites would dominate the lower part of the Earth orbit, below 600 km, with a latitude-dependent areal number density of between 0.005 and 0.01 objects per square degree at airmass <2. The author discusses the current population of artificial satellites in low Earth orbit. Ground viewers perceive these massive, low-altitude satellites as visibly bright, and the first Starlinks are visible to the unaided eye. I calculate the predicted number of lighted satellites based on latitude, season, and nightfall, and I list the many implications for ground-based astronomy. At lower latitudes where important observatories are located during winter, the satellites won't be lighted for six hours throughout the night (McDowell, 2020). On the other hand, hundreds of satellites may be simultaneously visible to unaided eye viewers in dark spots at low altitudes close to twilight at intermediate latitudes (45°–55°, for example, in much of Europe).

Being the only commercial LEO network with over 2 million subscribers and over 4000 operating satellites, SpaceX's Starlink network distinguishes out. Using several measurement sources, we provide an unprecedented comprehensive multifaceted study of Starlink's performance in this research. Firstly, we compare the worldwide performance of Starlink to that of terrestrial cellular networks using 19.2 million crowdsourced M-Lab speed tests from 34 countries since 2021. Second, we compare the performance of (i) Zoom cloud gaming and (ii) cloud conferencing with 5G and fibre to assess Starlink's suitability for real-time latency and bandwidth-critical applications. Third, to provide insight into the last-mile access and other variables influencing its performance, we evaluate data from RIPE Atlas probes that are equipped with Starlink. Lastly, we do controlled trials from two different Starlink dishes in two different nations and examine the effects of the satellite connections' globally synchronised "15-second reconfiguration intervals," which significantly alter throughput and latency. The most complete picture of Starlink's last-mile and worldwide performance to date is painted by our original research.

III. IMPLEMENTATION

A. Method

A mixed-methods strategy is used in this study to collect data using both quantitative and qualitative techniques. At the Federal Polytechnic Offa, surveys were given to the academic staff, administrative personnel, and students to find out how they now use the internet, what problems they experience, and what they think about satellite internet solutions. To assess the financial effects of putting Starlink services into practice, a cost-benefit analysis was also carried out, taking into account projected returns on investment, possible funding sources, and early setup expenses.

Satellite Distribution Channels

The satellite distribution channel forms the signal transmission medium between the uplink station and the customer terminal equipment. For Internet access services this is a two-way communication channel interconnecting the Internet with the consumer.

Consumer Terminal Equipment

The consumer terminal equipment includes an outside antenna, receiver and transmitter unit and an indoor modem unit per each consumer home. This is shown in Figure 1.

B. Materials Needed

To install Starlink, the following materials are required:

1. Starlink Kit: This includes the (See Figure 2):
   - Starlink satellite dish (also known as the phased array antenna)
   - Router (Starlink Wi-Fi router)
   - Power supply

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- Mounting hardware (e.g., tripod, mast, or roof mount)

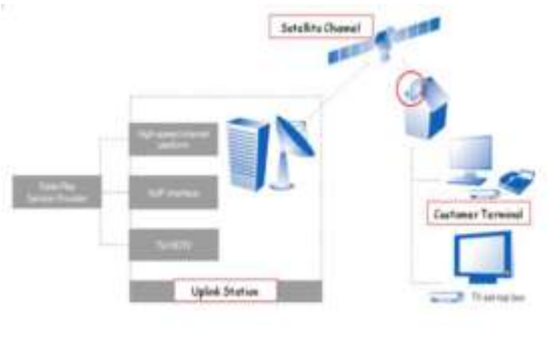

Figure 1: Direct-to-Home Internet (DTHi) network overview

Figure 2: Starlink Kit

2. Installation tools:
   - Drill and bits
   - Socket wrench or Allen wrench (for mounting hardware)
   - Tape measure
   - Level
   - Pencil and marker

3. Internet connection requirements:
   - A clear line of sight to the southern sky (for optimal performance)
   - A nearby power outlet

4. Other accessories:
   - Extension cable (for longer cable runs)
   - Surge protector (for added protection against power surges)
   - Grounding kit (for added protection against lightning strikes).

C. Implementation Procedure

Pre-Installation

1. Check availability: Ensure Starlink is available in your area.
2. Order the kit: Purchase the Starlink kit online or through the app.
3. Receive the kit: Wait for the kit to arrive (usually within 1-2 weeks).

Installation

1. Unbox the kit: Carefully unpack the Starlink router, modem, power supply, and dish.
2. Choose a location: Select a clear, elevated spot for the dish (ideally 100 feet off the ground).
3. Assemble the mount: Attach the dish to the mount and adjust the angle.
4. Connect the cables: Link the dish to the router and modem.
5. Power on Plug in the power supply and turn on the router and modem.
6. Download the app: Install the Starlink app on your device.
7. Follow in-app instructions: Complete the setup process, including scanning the QR code.

Alignment and Activation

1. Align the dish: Use the app to adjust the dish's angle and orientation.
2. Check signal strength: Ensure a strong signal (above 50%).
3. Activate the service: Wait for Starlink to activate your service (usually within 24 hours).

Post-Installation

1. Test your connection: Verify your internet connection and speed.
2. Secure your network: Change your Wi-Fi password and network name.
3. Update your router: Regularly update your router's software for optimal performance.

During the installation, the following were taken into consideration;

- Ensure a clear line of sight to the southern sky (between 25° and 55° elevation).
- Use the included cable clips to secure cables.
- Regularly clean the dish to maintain signal strength.

IV. RESULTS AND DISCUSSION

A. Analysis of Survey

The survey results revealed a striking trend, with over 60% of respondents expressing dissatisfaction with their current internet access. The primary concerns cited were slow speeds, hindering efficient online activities, and frequent outages, causing disruptions and lost productivity

However, the analysis of Starlink's pricing model presented a promising solution. While the initial investment for equipment and installation may

seem daunting, it can be offset by the potential benefits of:
- Improved educational outcomes, resulting from reliable and fast internet connectivity
- Increased enrollment rates, as students and educators alike benefit from enhanced online resources.

B. System Performance Evaluation
Latency Under Load

To study this, we measure the round-trip time (RTT) inflation, which is the difference between the maximum and least RTT observed during a speed test. The result demonstrated a significant increase in delay inflation under load, with Starlink experiencing RTTs rising by ≈2-4× to more than 400–500 ms while downloads were active. Note that Starlink has non-symmetric latency when it is busy. The 60th percentile of RTT increases to less than 100 ms globally during uploading, however, it is roughly 200 ms during downloading. We find similar activity when we run iperf over our managed terminals. Furthermore, Starlink may regulate uplink latency during under congestion by employing active queue management (AQM) techniques. This could be detrimental to applications that need both large bandwidth and low latency.

A. Commercialisation

A quantitative business model is expected to be developed for typical business scenarios faced by a business operation providing satellite broadband services on campus. This included the modelling of the important business relationships as well as the quantification of the respective input parameters. Once the model was constructed, the second step was to apply the model to provide output data for different business decisions and options that had to be considered. In particular, the model was applied to support and validate decisions regarding the following business considerations:
1) Selection of the most suited satellite scenario in terms of availability and cost: The inputs used for this analysis were satellite supply terms, teleport uplink terms, cost for hub platform and operation, link budget analysis and implementation costs.
2) Evaluation of the impact of different remote terminal equipment types (consumer or professional version): inputs include terminal equipment and implementation costs and network hub equipment costs.
3) Simulation of different pricing and billing models: usage-based billing based on the input data was compared against fixed rate billing.

For each of the above options the projected risks and returns were quantified in terms of sales revenue potential, time to positive cash flow, expected profit over 5 years and required financial investment. To make the scenario analysis more representative of uncertain market conditions, it was repeated for both a conservative and an aggressive market scenario, allowing market share after 5 years to range from 8% to 25%.

Exploring potential partnerships with government initiatives and educational grants could provide additional funding to support the implementation of Starlink services. This could help bridge the financial gap and make high-quality internet access a reality for a wider audience.

The results indicate that the Federal Polytechnic Offa's internet access problems might be resolved by using Starlink satellite technology. Starlink's dependable, high-speed connectivity can greatly improve both teachers' and students' educational experiences. Furthermore, the economic analysis shows that the initial investment is justified by the long-term advantages of better internet access, which include higher academic achievement and institutional prestige. To guarantee a successful implementation, potential issues including legal obstacles and the requirement for continuous technical support must be addressed.

V. CONCLUSION AND RECOMMENDATION

In underdeveloped communities, Starlink Internet Services has the potential to completely transform digital opportunities and internet access. We have a committed staff, state-of-the-art technology, and a solid business model, therefore we are sure we can prosper and grow our offerings to have a significant influence on the digital environment.

A strong argument for adoption is made by the study conducted to see whether Federal Polytechnic Offa's broadband internet connection might be commercialised by utilising Starlink satellite technology. The findings demonstrate the need for better internet connectivity, as the vast majority of respondents voiced unhappiness with the available options. Even though Starlink's pricing strategy necessitates an upfront investment, it offers a financially sensible option when taking into account the long-term advantages of improved academic results and higher enrolment rates.

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