




Tackling Sustainable Development Goal 9: Examining efforts by RENU to build critical national infrastructure

Nebert Ashaba 

nashaba@renu.ac.ug

Brian Masiga 

bmasiga@renu.ac.ug

 Department of Network Operations,
Research and Education Network for Uganda (RENU).
Makerere University | 8a Mabua Rd, Kampala

ABSTRACT

The United Nations Sustainable Development Goals (SDGs) provide a crucial framework for global progress and the advancement of human well-being. In Africa, the AfricaConnect 3 team, consisting of GEANT, UbuntuNet Alliance, ASREN, and WACREN, highlights the instrumental role of National Research and Education Networks (NRENs) in supporting the SDGs. This paper specifically focuses on SDG 9, which emphasizes the establishment of resilient infrastructure, inclusive and sustainable industrialization, and innovation.

In Uganda, the Research and Education Network for Uganda (RENU) is actively addressing SDG 9 by constructing the first marine optical fiber in Kalangala district, an island region in Lake Victoria. With 84 islands and a population of 67,000 individuals, Kalangala district faces economic challenges and resource isolation, leading to a high prevalence of HIV cases. RENU's efforts aim to extend reliable, high-speed Internet connectivity to underserved communities in Kalangala's island regions.

This examination explores RENU's deployment of underwater fiber optic cables connecting the mainland (Bukakata area) to Bugala Island, benefiting educational and research institutions on the main island, including hospitals, schools, and tertiary institutions. The paper presents findings and recommendations, including promoting infrastructure sharing between national research and education networks and commercial Internet service providers. It also suggests the adoption of technically and financially sustainable connectivity technologies by member institutions and the implementation of complementary access solutions such as community networks, municipal networks, and cooperatives.

By highlighting RENU's efforts and the outcomes of this examination, this paper provides valuable insights for leveraging NRENs to support global development initiatives, like SDG 9 with initiatives such as RENU's marine optical cable construction, and promote inclusive and sustainable development in underserved regions.

Keywords: Collaboration, Internet-based learning, Higher education, Research and education network, Underserved Communities, Community Networks, Internet Society Foundation.

ACKNOWLEDGEMENT

The efforts by RENU to establish optical fiber cable to the remote islands of Kalangala district have been made possible with a generous grant from the Internet Society Foundation through their Resiliency Program [13].

This program supports projects that increase network resiliency in communities prone to natural disasters so that these communities will be better able to prepare for and withstand the effects of natural disasters on Internet connectivity.

The Resiliency Program is one component of the Foundation's RARE (Resiliency & Responding to Emergencies) Program, which seeks to help communities enhance preparedness and build Internet resiliency when faced with adverse events such as natural disasters.

1. INTRODUCTION

1.1. Background

The United Nations Sustainable Development Goals (SDGs) are a set of 17 global goals adopted by all United Nations (UN) Member States in 2015 as part of the 2030 Agenda for Sustainable Development. These goals are a universal call to action to end poverty, protect the planet, and ensure prosperity for all by 2030. They address various social, economic, and environmental challenges facing the world today and are interconnected, recognizing that progress in one area often depends on progress in others.

SDG 9 is one of these 17 goals, and it focuses specifically on "Industry, Innovation, and Infrastructure with a specific goal of building resilient infrastructure, promoting inclusive and sustainable industrialization, and fostering innovation.

Different organisations are tackling this through different efforts including RENU providing Internet connectivity to the remote island of Kalangala surrounded by Lake Victoria. Reliable connectivity will be established by the use of an underwater optical fibre cable and when established, will improve service delivery in schools, tertiary institutions and research organisations in the region by enabling research, learning and collaboration.

1.2. Problem Statement

Connectivity to institutions in Uganda's underserved communities has been limited by inadequate investment from different for-profit (commercial) Internet service providers (ISPs), as such investments do not guarantee significant returns on investment. This is exacerbated by factors ranging from geographical location to terrain, and the demographics of the given area. Income levels also contribute to the investment drive of commercial companies.

Such factors discourage many companies from expanding their network footprints and substituting their legacy provider equipment with cutting-edge technologies, as such cutovers are usually capital-intensive.

With the ever-changing research-centred education curriculum in different institutions of learning and the need for fast collaboration among different research organizations in Uganda with their partners across the globe, the Internet is currently an essential and widely used tool.

1.3. Objectives

This paper explores RENU's efforts to contribute to global development agendas by establishing inclusive and cost-effective solutions to the community through deploying reliable

Internet connectivity using fiber cable to Kalangala islands and also presents findings and recommendations on how to promote connectivity in under-served communities.

2. Literature Review

2.1. Internet service connectivity landscape in Uganda.

According to the Uganda Communications Commission (UCC) Market Report for the third quarter (3Q) financial year (FY) 2022-2023 between January to March 2023, Internet subscriptions experienced significant growth, adding *1.2 million new internet subscriptions and reaching a total of 27 million in the quarter ending March 2023. This was the second quarter in a row that saw growth, demonstrating a steadily rising Internet use trend.

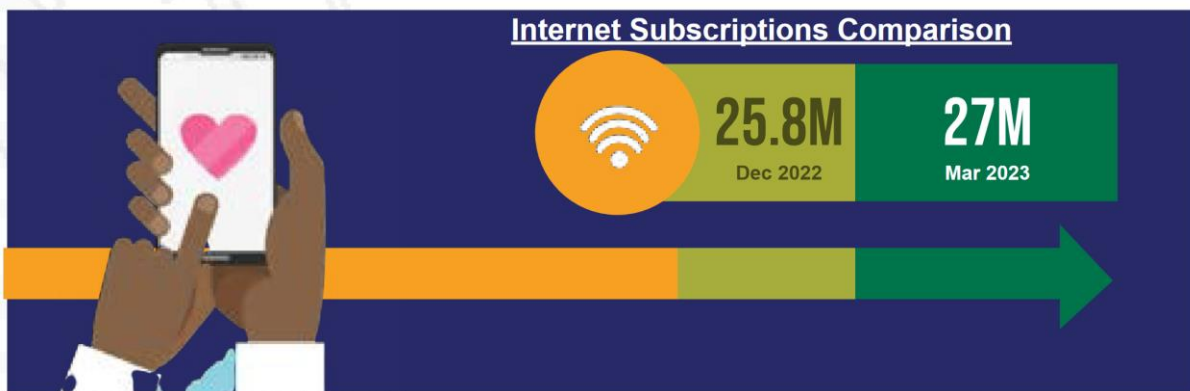


Figure 1: Internet Subscriptions Comparison

* These numbers are based on the total number of subscriptions that use above 5MBs of data a month.

The increased use of mobile phones and other data devices like tablets to access the internet is primarily responsible for the surge in subscriptions. The strong marketing campaigns for Fiber-to-the-Home (FTTH) plans and Internet of Things (IoT) gadgets like car tracking devices by the telecom industry are accountable for their success [1].

Telecom companies like MTN Uganda, Airtel Uganda, and Africell provide mobile internet services. MTN Uganda and Airtel Uganda are the main companies dominating the Ugandan telecom market. With a 55% market share, MTN Uganda is the market leader with Airtel Uganda as the next biggest competitor [2].

Other companies like RENU run a private network that specializes in the provision of Internet connectivity and related services like cloud to research and education institutions in Uganda.

2.2. Challenges hindering Internet connectivity in Uganda.

Limited Infrastructure in Rural Areas: The lack of adequate Internet connectivity in rural and distant places is one of the biggest obstacles. Rural areas lack or have sporadic connectivity due to the concentration of fiber optic cables and network infrastructure footprint in urban areas [3].

Affordability: Internet services are often considered expensive for many Ugandans, particularly those with low incomes. High data costs relative to average incomes make it challenging for some segments of the population to access the Internet regularly [3].

Geographical Challenges: Uganda is land-locked with no direct access to sea cables but to only overland cables [4] and its diverse geography, including lakes, rivers, and hilly and rugged terrain as shown in Figure 2, poses challenges for infrastructure deployment, including the extension of fiber optic cables.



Figure 2: RENU Field Visit to Kalangala Cluster Office

Quality of Service: Users in urban areas sometimes experience network congestion and slow internet speeds, especially during peak usage hours. This affects the quality of service, making it less reliable for tasks such as remote work and online learning. ISPs therefore have to proactively monitor customer links and occasionally visit these sites to carry out tests and confirm optimal performance forexample during field checks as in Figure 3.



Figure 3: RENU Engineer carrying out tests at Jaana HC in Kalangala islands.

Limited Digital Literacy: Many Ugandans lacked the digital literacy skills needed to make effective use of the Internet. This is particularly challenging for educational institutions and related initiatives that aim to leverage the Internet for learning [3].

2.3. Existing Initiatives to expand Internet connectivity in Uganda.

Expanding internet connectivity in Uganda has been a priority for the government and various organizations. Several initiatives have been launched to address the challenges and bring the benefits of the Internet to more Ugandans.

Initiatives by non-governmental organisations include the Kalangala Connect Project where RENU, with funding from the Internet Society (ISOC) Foundation, is building an optical fiber cable to extend reliable and high-speed Internet to the islands of Kalangala.

Other efforts by governmental organisations include the National Information Infrastructure (NII) Project where the government of Uganda is extending fiber optic connectivity to underserved areas, including rural regions [6]. This project aimed to improve internet access and digital services in remote areas.

Another project by the government of Uganda managed by the Uganda Communications Commission (UCC) is the Uganda Communications Universal Services Access Fund (UCUSAF) where UCC partnered with RENU and Airtel to provide dedicated Internet connectivity links with a capacity of 5Mbps to over 90 schools [5].

3. Findings, Projected Benefits and Recommendations

3.1. Findings leading up to Kalangala Connect Project

Kalangala district has a total population of over 67,200 people (according to the 2020 projection by the Uganda Bureau of Statistics) with only 15 health facilities and 56 schools.

The area is affected by natural disasters like floods and cyclones [8] which in turn lead to a widespread of diseases like Cholera, typhoid etc. which puts a strain on the inadequate and ill-equipped health facilities on the island. The problem of such inadequate facilities is made worse by the island's undeveloped transport system as elaborated in the 2020 US Mission report to the Ugandan people [7].

RENU believed that the Internet could help bridge the gap. Thus at the start of 2022, RENU intervened and connected fourteen (14) health facilities in Kalangala Islands (Bwendero HC III, Kalangala Cluster, Kalangala DHO, Kalangala HC IV, Bufumira HC III, Mulabana HC II, Kachanga Island HC II, Kasekulo HC II, Bubeke HC III, Lujabbwa Island HC II, Lulambwa HC III, Bukasa HC IV, Jaana HC II and SIAAP) on the wireless connection [9], but that is very unstable.



Figure 4: Sector Out Door Unit (ODU) Installed serving Bufumira HC III

The unstable Internet connection is also a general problem on the island because Uganda's commercial Internet Service Providers (ISPs) shun it due to the sparse population. It thus does not make business sense for ISPs to establish a resilient network presence in the district. The Island district's geographical location is also to blame for the poor connectivity [12].



Figure 5: RENU field team members walking to an island site in Kalangala

Such problems affect essential service delivery, particularly in the education and health sectors especially where long distances need to be made to access such vital centers as in Figure 5.

3.2. Projected benefits from the Kalangala Connect Project

The project will be implemented in Bugala Island found in Kalangala District in the Central region of Uganda.

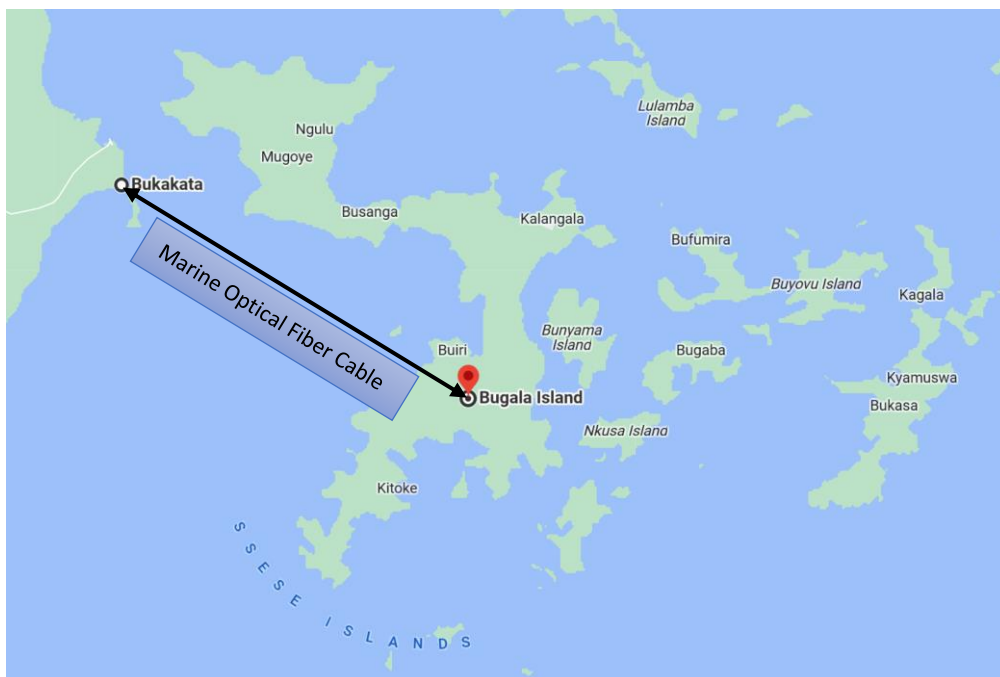


Figure 6: OFC Illustration from Bukakata to Bugala Island

Easier access to Information and Education materials: Reliable Internet access will enable residents of Kalangala to access a wealth of information, educational resources, and online courses. This will lead to improved educational outcomes, including higher literacy rates and increased knowledge across various subjects.

Enhanced Healthcare Services: Healthcare facilities on the islands will benefit from telemedicine services, allowing for remote consultations, diagnosis, and monitoring of patients. RENU is already connecting over 9 facilities under the Center for Disease Control (CDC)/Rakai Health Sciences Program (RHSP) project using Long-Term Evolution (LTE) and microwave access methods.

Economic Opportunities: Access to the reliable Internet will open up new economic opportunities in different fields including agriculture, tourism, and online government services that aid commerce. Residents will be able to easily explore online entrepreneurship, access e-commerce platforms to sell products and connect with markets beyond the islands.

Disaster Preparedness and Response: Access to the Internet will improve disaster preparedness and response mechanisms. Communities will be able to swiftly receive early warnings and access resources and information during emergencies.

This intervention to improve Internet connectivity will improve the area's education, health and economic standards, thus hastening the island's social and economic development.

3.3. Recommendations

Reducing Internet costs and expanding access, especially to underserved areas is crucial for bridging the digital divide and fostering economic and social development. Here are recommendations to achieve these goals:

Infrastructure Sharing: UCC is leading regulatory efforts in promoting infrastructure sharing especially through revising the national telecom licensing framework [10] to incorporate such new dynamics. The commission has also published different guidelines on infrastructure deployment and sharing with an aim to encourage Internet service providers (ISPs), including national research and education networks (NRENs), other (commercial) Internet service providers, and telecom companies to share infrastructure such as fiber optic cables, cell towers, and data centres [11]. This reduces capital expenditure and operational costs, which can be passed on to consumers through lower prices.

Adoption of technically and financially sustainable connectivity technologies by member institutions: Internet service providers especially national research and education networks are recommended to adopt the use of cost-effective and technically-capable technologies, especially for last-mile connectivity. Innovative solutions like fixed wireless access for example 4G LTE and 5G, satellite, and mesh networks can be cost-effective, especially for reaching remote areas [12].

Use of complementary access solutions such as community networks, municipal networks, and cooperatives: Combining backhaul technologies (like Plesiochronous digital hierarchy (PDH) and Synchronous Digital Hierarchy (SDH)/Synchronous optical networking and Point-to-multipoint microwave-access technologies) with access solutions such as community setup and managed networks, for example, a Community LTE (CoLTE) eases the building of financially sustainable networks mostly in underserved areas [12]. Where there is no practical way to provide continuous coverage or multiple cells, community networks are the right answer for distant settlements and islands where customers can still benefit from mobile broadband connectivity.

Discussion, Future Work and Conclusion.

The Kalangala Connect project, currently at the inception stage, will be done in phases with the end goal of establishing a dedicated marine optical fiber cable from Bukakata mainland to Bugala island in the Kalangala district. Robust access technologies, for example, Fiber to any given site (commonly referred to as FTTx) including fiber to the home (FTTH) will drastically reduce Internet costs and aid the expansion of fiber footprint especially when users are involved in deployments [14]. This will greatly reduce dependence on unreliable wireless technologies such as microwave technology in the future.

The success of the NREN's member institutions' collective digital future hinges on how well and how quickly we deliver the affordable, accessible, resilient, and reliant digital connectivity required for the establishment and operation of an inclusive digital society with the aim of fostering collaboration in research and education.

References

[1] Uganda Communication Commission Market Report 3Q FY 2022-2023 Jan-Mar-2023. [Online]. Available: <https://www.ucc.co.ug/wp-content/uploads/2023/08/UCC-Market-Report-3Q-FY-2022-2023-Jan-Mar-2023-compressed-1.pdf>. [Accessed: September 9, 2023].

[2] Telecommunication Companies in Uganda: Market Players and Competitive Dynamics. [Online]. Available: <https://isp.page/news/telecommunication-companies-in-uganda-market-players-and-competitive-dynamics/>. [Accessed: September 9, 2023].

[3] Expanding internet connectivity to underserved communities in Uganda will boost economic transformation. [Online]. Available: <https://www.independent.co.ug/comment-expanding-internet-connectivity-to-underserved-communities-in-uganda-will-boost-economic-transformation/>. [Accessed: September 9, 2023].

[4] D. Ó Briain, D. Denieffe, Y. Kavanagh and D. Okello, "Rebuilding the Internet Exchange Point in Uganda," 2017 28th Irish Signals and Systems Conference (ISSC), Killarney, Ireland, 2017, pp. 1-6, doi: 10.1109/ISSC.2017.7983601.

[5] Over 1,000 Schools Benefiting from UCC's ICT Labs Project. [Online]. Available: <https://chimpreports.com/over-1000-schools-benefiting-from-uccs-ict-labs-project/>. [Accessed: September 9, 2023].

[6] National Backbone Infrastructure Project (NBI/EGI). [Online]. Available: <https://www.nita.go.ug/projects-service-portfolio/national-backbone-infrastructure-project-nbiegi>. [Accessed: September 9, 2023].

[7] 2020 Report to the Ugandan people from the U.S. Mission to Uganda. Page 4. [Online]. Available: <https://ug.usembassy.gov/wp-content/uploads/sites/42/2020-Report-to-the-Uganda-People-Low.pdf>. [Accessed: September 9, 2023].

[8] Kalangala Cyclone Survivors Receive Relief 6 Days Later [Online]. Available: <https://ugandaradionetwork.net/story/kalangala-cyclone-survivors-receive-relief-6-days-later>. [Accessed: September 9, 2023].

[9] RENU Network Reaches the Islands!, RENU Twitter feed. [Online]. Available: https://twitter.com/RENU_256/status/1483716148902477826?s=20. [Accessed: September 9, 2023].

[10] UCC explains review of telecommunications license framework [Online]. Available: <https://www.pmldaily.com/news/2020/01/ucc-explains-review-of-telecommunications-license-framework.html>. [Accessed: September 10, 2023].

[11] The Uganda Communications Commission guidelines on infrastructure deployment and sharing [Online]. Available: <https://www.ucc.co.ug/wp-content/uploads/2022/02/THE->

UGANDA-COMMUNICATIONS-COMMISSION-GUIDELINES-ON-INFRASTRUCTURE-DEPLOYMENT-AND-SHARING.pdf. [Accessed: September 10, 2023].

[12] Jonathan Brewer, Yoonee Jeong, and Arndt Husar, “LAST MILE CONNECTIVITY: ADDRESSING THE AFFORDABILITY FRONTIER”. ADB Sustainable Development Working Paper Series. No. 83 | December 2022. [Online]. Available: <https://www.adb.org/sites/default/files/publication/847626/sdwp-083-last-mile-connectivity-affordability-frontier.pdf>. [Accessed: September 10, 2023].

[13] Expanding Internet access, connectivity and resiliency: meet our newest grant cohort [Online]. Available: https://www.isocfoundation.org/2023/03/expanding-internet-access-connectivity-and-resiliency-meet-our-newest-grant-cohort/?utm_source=Internet+Society+Foundation&utm_campaign=9947e48437-BOLT-Resiliency-March2023&utm_medium=email&utm_term=0_c552f5914f-9947e48437-243954092. [Accessed: September 10, 2023].

[14] Domingo Vilar, Albert, 1984-. User involvement in FTTH deployments as a key to success. 2015 B 4134-2016 <http://hdl.handle.net/10803/348882>

Appendices



Figure 7: RENU Field Visit to Jaana Health Center II



Figure 8: RENU Field Visit to Mulabana Health Center II



Figure 9: RENU Field Visit to SIAAP Health Center II