BETTER APPROACH TO MARGINALIZED AREA NETWORKS (B.A.T.M.A.N.)

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Abstract

According to the Kenya National Census 2019, only one in five Kenyans has access to the internet. In July 2016, the UN declared access to the internet to be a human right. Yet the digital divide between the developed world and the global "south" has become even starker in the midst of the pandemic. Information saves lives and to have the internet is to have access to a lifesaver.

Realistically though, telcos have barely any inventive to deploy telecommunication infrastructure in rural areas largely due to unfavourable market scenarios. However, alternative network deployments coupled with innovative engineering can ensure affordable and accessible internet for the marginalized communities. This paper gives insights, examples and a path to action by engineers for the community as we engineer a post COVID-19 future.

Keywords: Post COVID-19, alternative network deployments, connectivity, SDGs

1 Introduction

In 2016, a report from the Human Rights Council of the United Nations General Assembly declared access to the internet to be a basic human right [1], integral to allowing individuals to "exercise their right to freedom of opinion and expression." According to DataReportal report published in February 2020, there were 22.86 million internet users in Kenya in January 2020 and internet penetration stood at 43%. This is in contrast to 52.06 million mobile connections in Kenya in January and a 98% mobile connectivity penetration.

Access to meaningful, reliable, secure and affordable internet is no longer a luxury but a basic moral human right. However, there still exists a digital divide, especially in rural, marginalized and underserved areas where it is not economically viable for traditional telecoms and internet service providers to reach. Additionally, socio-economic barriers to getting connected still exist among these marginalized population groups that hinders their access to the internet.

In line with this problem, this document proposes alternative network deployments which include a set of network access models that have emerged in the last decade with the aim of providing internet connections following topological, architectural, governance and business models that differ from the so called mainstream network deployments where a telco deploys the infrastructure connecting the users, who pay a subscription fee to be connected and make use of it. [2]

2 Materials and Methods:

The methodology employed in this report is split into three parts:

1. To compile the map of other network deployments initiatives existing currently;
2. To spot the challenges they face; and
3. To recommend better approaches to their deployment

The term "Alternative Network" proposed during this document refers to the networks that don't share the characteristics of "mainstream network deployments". Therefore, they'll share a number of the subsequent characteristics:

- Relatively small scale (i.e., not spanning entire regions).
- Administration might not follow a centralized approach.
- They may require a reduced investment in infrastructure, which can be shared by the users and commercial and non-commercial entities.

- Users in Alternative Networks may participate within the network design, deployment, operation, and maintenance.
- Ownership of the network is usually vested within the users.

Alternative Networks, considered self-managed and self-sustained, follow different topology patterns [3]. Generally, these networks grow spontaneously and organically, that is, the network grows without specific planning and deployment strategy and therefore the routing core of the network tends to suit an influence law distribution.

Moreover, these networks are composed of a high number of heterogeneous devices with the common objective of freely connecting and increasing the network coverage and also the reliability. Although these characteristics increase the entropy (e.g., by increasing the amount of routing protocols), they need resulted in an affordable solution to effectively increase the network size. One such example is TunapandaNET [4], which has had an exponential rate within the number of operating nodes and impact within the past five years.

For this research, the MAZI toolkit for location-based collective awareness, and CoLTE for IP-based network deployment were studied as a part of the technological considerations for the research.

3 Results:

A full map of the description and categorization of community and alternative networks is available online. [5]. See the table below as a summary of the findings:

Table 1: Summary of Community Networks in Africa

Name	Country	Started	Active?	# of Nodes	Internet?	Location	Funds for bootstrapping
Mesh Bukavu	Democratic Republic of the Congo (DRC)	2015	Yes	10 - 15	No	Urban	External
Pamoja Net	DRC	2015	Yes	6	Yes	Rural	External
Mesh Goma	DRC	2015	No	15	No	Urban	External
Akwapim Community Wireless Network	Ghana	2005	No	20	Yes	Rural	External
TunapandaNet	Kenya	2010	Yes	4	No	Urban	External
Connecting Eenhana	Namibia	2015	Partially	7	No	Rural/ Urban	External
Fantsuam Community Wireless Network	Nigeria	2005	Yes	1	Yes	Rural	External
Ibadan WUG	Nigeria	?	Yes	22	Yes	Urban	Internal
Abaarso	Somalia	2103	?	?	Yes	Urban	External
Siyakhula Living Labs – Dwesa-Cwebe	South Africa	2005	Partially	17	Yes	Rural	External
Siyakhula Living Labs - Ntselamanzi	South Africa	?	Partially	10	Yes	Rural/ Urban	External
Rural Telehealth	South Africa	2003	No	7	Yes	Rural	External
Peebles Valley Mesh Network	South Africa	2005	No	6	Yes	Rural	External
Bo-Kaap Mesh	South Africa	2010	No	75	Yes	Urban	External
Orange Farm	South Africa	?	?	?	Yes	Urban	External
Kranshoek Mesh	South Africa	2011	Yes	30	Yes	Rural/ Urban	Internal
Zenzeleni Networks	South Africa	2013	Yes	12	Yes	Rural	External
Scarborough WUG	South Africa	2003	No	>200	Yes	Urban	Internal
SoWUG	South Africa	2010	Yes	29	Yes	Urban	External

Cape Town WUG	South Africa	?	Yes	>100	No	Urban	Internal
Johannesburg WUG	South Africa	?	Yes	>100	No	Urban	Internal
Durban Wireless Community	South Africa	2004	Yes	50	No	Urban	Internal
BB4All	South Africa	2009	Yes	?	Yes	Rural/ Urban	External
Pretoria Mesh	South Africa	2005	Yes	20	Yes	Urban	External
ICT4RED	South Africa	2012	Yes	12	Yes	Rural/ Urban	External
Home of Compassion	South Africa	2015	Yes	20	Yes	Urban	External
The ICT for Rural Development Project	Tanzania	2006	Yes	?	Yes	Rural	External
Sengerema Wireless Community network	Tanzania	2008	No	17	Yes	Urban	External
Mesh Sayada	Tunisia	2013	No	12	No	Urban	External
BOSCO Uganda	Uganda	2007	Yes	43	Yes	Rural	External
Macha Works	Zambia	2006	Partially	99	Yes	Rural/ Urban	External
Murambinda Works	Zimbabwe	2000	Yes	?	Yes	Rural/ Urban	External

A description of the categories in a number of the variables within the table is provided below [4]:

- Partially Active refers to those networks that had been Active but the people reporting about them acknowledged that, at the time when the map was created, some sections or the entire network were facing serious sustainability issues.
- Rural/Urban refers to those community networks deployed in towns relatively removed from big cities/provincial capitals (referred to as Urban), but still having access to some infrastructure (tar road, hospital, sewage, etc.) lacking in additional remote rural areas.
- Internal funds for bootstrapping is related to those community networks where the majority of the investment for the telecommunications infrastructure was provided by the users, as against those where this investment was provided by an external donor.

Considerations to be made to enhance alternative network deployments – the Four Horsemen of different network deployments:

1. Technology Considerations
2. Legal Considerations
3. Economic Considerations
4. Social Considerations

4 Discussion:

Different governance models are present in Alternative Networks. They will range from some open and horizontal models, with a full of life participation of the users (e.g., Community Networks) to a more centralized model, where one authority (e.g., an organization or a public stakeholder) plans and manages the network, whether or not it's (total or partially) owned by a community.

Regarding sustainability, some networks grow "organically" as a results of the new users who join and extend the network, contributing their own hardware. In another cases, the existence of previous infrastructure (owned by the community or the users) may lower the capital expenditures of an operator, who can therefore provide the service with better economic conditions.

Multiple technologies may be preoccupied for the deployment [6]:

- Standard Wi-Fi. Many different Networks are supported the quality IEEE 802.11 [IEEE.802.11] using the Distributed Coordination Function.

- Wi-Fi-based Long Distance (WiLD) networks. These can work with either Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) or another Time Division Multiple Access (TDMA) Media Access Control (MAC)
- TDMA. It will be combined with a Wi-Fi protocol, in a very non-standard way [airMAX]. This configuration allows each client to send and receive data using pre-designated timeslots.
- 802.16-compliant (Worldwide Interoperability for Microwave Access (WiMax)) [IEEE.802.16] systems over non-licensed bands.
- Dynamic Spectrum Solutions (e.g., supported the employment of TV White Spaces). A collection of television frequencies which will be utilized by secondary users in locations where they're unused, e.g., IEEE 802.11af [IEEE.802.11AF] or 802.22 [IEEE.802.22].
- Low-cost optical fiber systems are wont to connect households in numerous places
- Community future Evolution (CoLTE) can even be wont to deploy IP-based networks

The social objectives are the most shaping factors of any project. Computer networks, aiming at an experimental network for hackers, have very different implications in the slightest degree levels than aiming at a general-purpose production network for a complete population. within the same manner, the implications of aiming at a network for dozens of users don't seem to be the identical as aiming at one for each one in every of the hundreds, thousands, or millions nearby. The social objectives don't have to be necessarily prescribed since the start and might evolve over time, but an early tentative definition facilitates initial progress because many of the critical decisions needed to maneuver forward depend upon them.

The first is to accumulate knowledge on the system as a whole: how the system is structured where the choice network are developed, what the basic components are, like the authorities that may regulate and bodies that may legislate, and the way they relate to every other. The internalization of this information is crucial given the prevailing strong economic interests of the telecommunications sector and also the influence that their lobbies usually enjoy.

5 Conclusion:

The telecommunications sector could be a highly regulated area, and alternative networks cannot afford disrespecting established rules, because the lack of compliance to the legal framework would only jeopardize their development. Although alternative networks are local initiatives and thus develop their activity under diverse legislative and regulatory frameworks, some practical guidance is applicable to just about all contexts, irrespective of the precise domestic legislation.

The development of a financial system with revenue streams and economic exchanges is prime to realize sustainability and thus to expand the choice network at a later stage. Even in resource-limited environments where external funds are needed to initiate the project or to contribute and maintain it over time, the event of a neighborhood economy is that the handiest thanks to make sure the healthy survival of the network and its successful evolution, that is, to expand within the quality of services and therefore the number of users served.

Technological matters must be addressed in accordance to social objectives. From this attitude, technological decisions must even be driven by the chance criterion to optimize the extension of the network and therefore the quality of services offered. Furthermore, these decisions must be taken in line with the economic capability and legal possibilities.

Acknowledgement:

This work has stood on the shoulders of giants pushing for innovative and alternative approaches to the deployment, governance and use of the internet, hence I must acknowledge the Internet Society, the International Telecommunication Union and Commotion Wireless for the profound insight I have been privileged to draw from their knowledge base.

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