

# Towards Sustainable Broadband Communication in Rural Areas

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**Abstract.** As part of the development of a general strategy, we present a framework for the establishment of sustainable broadband communication in under-served areas of developing regions often described in terms of low population density, low purchasing power, intermittent power supply, and lack of competent human resources. Due to an increasing political awareness of the importance of ICT for development, not least due to the explosive expansion of the mobile phone networks, such regions are getting more attention also regarding broadband infrastructure. Our research includes experimental validation of a community networking approach based on affordable high-performance, low-effect technologies focusing on pilot projects in Tanzania.

**Keywords:** Community networks, Broadband Networks, Developing regions, Rural Areas, economics, sustainability.

## 1 Introduction

There is an increasing awareness of the importance of Information and Communication Technologies (ICT) for development, including both mobile access and broadband communication infrastructures. There are clear indications that this awareness is now affecting mainstream planning of development activities of key institutions. ITU has formulated a broadband vision: “Build broadband networks and everything else will follow [1]”. The 2009 world bank report on Information and Communication for Development observed a correlation between broadband connections and the economy of a region [4].

Although there is no reason to believe that the societies and citizens in developing regions have different communication needs than those in developed regions, the broadband penetration in developing regions, especially Africa, is very poor compared to developed world [2]. There are many reasons for this: first, the often under-developed policies and regulatory frameworks create political risks adding to the commercial risks. Second, there is a lack of supporting infrastructures, such as optical fibre networks, electrical power and developed supply chains. Third, the traditional business models used by most network operators and service providers lead to high perceived commercial risks.

There is a misconception that communication networks and services will be provided by commercial markets, if only there is a demand. This may be true

in densely populated areas of developed regions. It is, however, definitely not true in developing regions nor in sparsely populated areas of developed regions. We argue that for developing regions to catch up, public investments have to be used as drivers. Although most national budgets are strained, there is currently the opportunity to take advantage of the commitment of the developed world to support efforts leading to the Millennium Development Goals (MDG) [3].

To achieve this, we propose the creation of self-sustained local area broadband islands serving local communication needs, even if there are currently no, or only narrowband, external connections due to the unavailability or too high price of uplinks. This kind of networks are easy to build and increasingly found in many under-served areas. We use the term “local” and “community” networks interchangeably to refer to district or municipal networks. Also, broadband in this paper is referring to high speed connectivity within the local network, not necessarily the uplink.

We demonstrate, in a case study, that financial and operational sustainability can be achieved for communication networks in rural and remote areas, given that a proper environment exist. Our methodology is based on both own and related academic and professional work as well as the evaluation of implementations specific to a project in Tanzania.

The organization of the rest of the paper is as follows. Section 2 highlights related work in this area. In Section 3, we discuss the framework required to create a sustainable broadband networks in under-served areas. Section 4 is a presentation of how we applied the framework into a running project in Tanzania. A summary and conclusions is provided in Section 5.

## 2 Related Work

We have found no previously published work taking a holistic approach that is similar to ours. Previous studies address specific issues, relating to either technology [11,15], application [13] or environmental challenges [12] in under-served areas. We will discuss two references that closely relate to our work.

Gillett et al. [14] observed that certain geographical areas and populations lag behind others in terms of Internet access. The author noted that municipals can contribute in different roles to accelerate broadband in such areas, such as a broadband user creating a demand, as policy-maker defining the rules, financial supporter and infrastructure developer. In our experience, due to the fact that most municipals in developing countries rely completely on the central government for their budget and policies, we believe that municipals in these areas can facilitate broadband mainly by being consumers of broadband services in their own work procedures and as fall-back producers of broadband services in a utility branch as long as there is no or little commercial interest to provide such services.

Munir et. el. [5] proposed three steps to follow when deploying a Municipal Wireless Networks: step 1: identifying goals, stakeholders and governing policy; Step 2: designing the infrastructure and securing funding; and step 3: actual

implementation. The authors assume that the municipals are “ICT aware” and that they have access to technical competence and funding opportunities. These assumptions do not always apply in the under-served areas we are focusing on.

### 3 Framework for Establishment of Sustainable Broadband Markets

The balance between demand and supply required to sustain a broadband market in under-served areas can be improved beyond the limitations of traditional approaches through community interventions such as: raising ICT awareness and capacity building; understanding and developing the market; providing services that optimize existing solutions; innovative use of existing technologies; and the use of flexible business models. We will discuss these items in detail.

#### 3.1 Awareness Raising and Capacity Building

There is a need to raise the awareness and competence of all stakeholders on the communication market, among consumers so that they can demand the services they need to improve their performance and among producers to become competitive by providing innovative solutions in cost-effective ways and to manage and maintain the existing broadband networks and services efficiently.

In our approach, the awareness raising and capacity building is provided by involving students and faculty members at universities, local government and private sector in a cooperative multi-stakeholder framework for integration of development projects and problem-oriented, project driven learning, including individual learning towards master and doctoral level degrees, organisational learning towards certification and consortia learning towards a deeper understanding among all stakeholders of a modern communication market [17].

#### 3.2 The Broadband Market

A communications market consists of consumers, producers, policy-makers and regulators. The paper discusses the market at a municipal level.

**Consumer:** The consumers own the applications and requests for services. Municipals are the main buyers of broadband services for internal operations, or services to the citizens. Other consumers include the private sector, community organisations and households/citizens.

**Producer:** On the producer side there is a whole supply chain including the network operator(s), application developers, service and content providers.

Municipals are content producers for the public consumptions and business entities. Private sector should develop contents and other services such as trainings for its own consumption as well as selling to the government.

**Policy-Maker and Regulator:** Regulatory authorities are set up to translate legislation passed by the policy-makers into operational regulatory frameworks, to arbitrate between the interests within and between the consumer and producer groups, and to give government a fair share of the revenues of the communication business in terms of license fees. Our model includes a component focusing on advocacy to include a special category in the regulatory framework for community networks in under-served areas of no or little commercial interest, turning license fees into support, e.g. from universal access funds.

Even though most of the policies are spelled out by the central government, municipalities should facilitate whatever is in their power and provide feedback to get attention to their special needs.

### 3.3 Application and Services

When discussing broadband communication, there is often a fixation on Internet access to connect the under-served areas into the global village. However, in our approach, this is secondary as connection to the Internet (uplink) is very expensive. Our primary focus is on applications within the local network.

The purpose is to support the development of basic public sector services required to progress towards the MDGs, primarily healthcare, education, local administration and support to local entrepreneurs. Applications include telemedicine for consultation between rural health centres and district or referral hospitals, tele-teaching and sharing of learning material between schools, public administrative services, portal for market information and for marketing of local entrepreneurs, etc.

### 3.4 Technology

Technology selection at a specific location is affected by the demand for services, the regulatory environment, the physical environment, and what is possible to implement and maintain sustainably. The availability of affordable high-performance, low-effect network elements based on open source software and selected off-the-shelf hardware components facilitates deployment of advanced networks. How advanced depends mainly on the availability of communication links. The Wireless Fidelity (WiFi) technology has gained acceptance in community networks due to its mass production, making it cheap. Also, it is easy to install and maintain.

Optical Fibre Links has high capacity and durability but requires specialized training and tools for installation and maintenance. Any civil works involved in fibre deployment is expensive although there are sometimes innovative cooperative approaches to this in rural areas. There are examples from rural areas of developed regions where local inhabitants sitting on right of way and appropriate machinery, contribute the civil work part while the telecom or power utility company provides the fibre cables and active network elements [10]. Once the fibre link is available, 1Gbps link up to some 160 km and 10Gbps up to some 80 km are very cheap. Longer distances require signal amplifiers.

### 3.5 Business Model

Our approach is to attract the capital expenses (CAPEX) required to establish the network from the government budget or development agencies to support basic public services while the operational expenses (OPEX) has to come from consumers as fees paid for the services consumed.

The management model will be affected by the source of funding as well as the guiding policies. However, the public private partnership (PPP) is the most suitable as it will combine the benefits from both sides: the entrepreneurship and technical know how from the private sector and access to funding from the government side.

## 4 The Serengeti Pilot

The ICT for Rural Development (ICT4RD) in Tanzania [7] is a multi-stakeholder research and development project with the objective to develop a scalable model for establishment of sustainable broadband networks in under-served areas. To explore possible technical solutions, economical parameters, business models and models for support to local entrepreneurs, the program established two pilot sites. This paper will reference the Serengeti pilot, deployed in the north of Tanzania, connecting two district capitals to prove the proposed framework.

### 4.1 Awareness Raising and Capacity Building

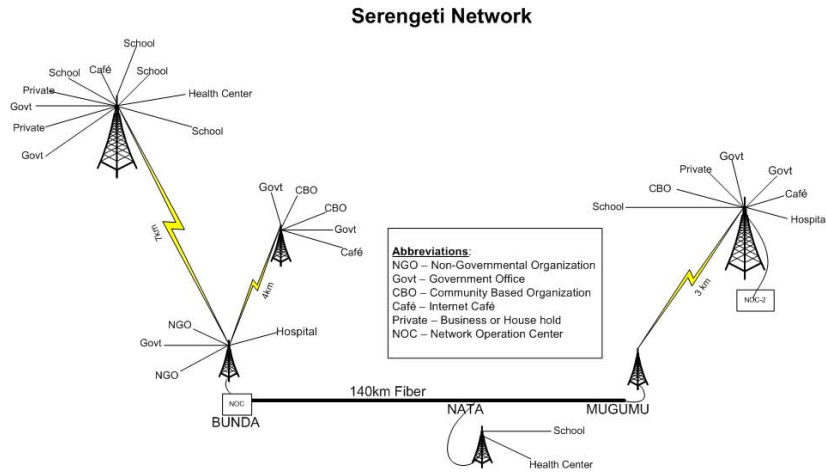
The project conducted several ICT awareness raising workshops and training seminars. Eight Tanzanians have been trained at a master of science level. During their thesis work, all of them directly contributed in the technical design and implementations. Also, most of the applications are developed or customized using students from the academic partners in collaboration with locals.

### 4.2 The Broadband Market

The findings of the baseline study carried out in 2006 [8] revealed that main activities in both districts are agriculture and livestock, carried out by about 90% of the population. Also, both districts rely in the central government for about 95% of their budgets. When assessing the market in 2008, the author [9] observed both municipals having several computers, also produce a lot of information public consumption. Furthermore, the author noted a vibrant private sector and community organisations who could both consume and produce broadband services.

Policy - Tanzania passed its Universal Communications Service Access Act in 2006 and the Universal Communications Service Access Regulations in 2009. The establishment of the Universal Communications Service Access Fund (UCAF) was completed in 2009. The government has promised to use this fund to expand connectivity in rural areas.

The Serengeti network diagram is provided in Fig. 1, the network implementation is detailed in [6].



**Fig. 1.** Serengeti Network

### 4.3 Services and Applications

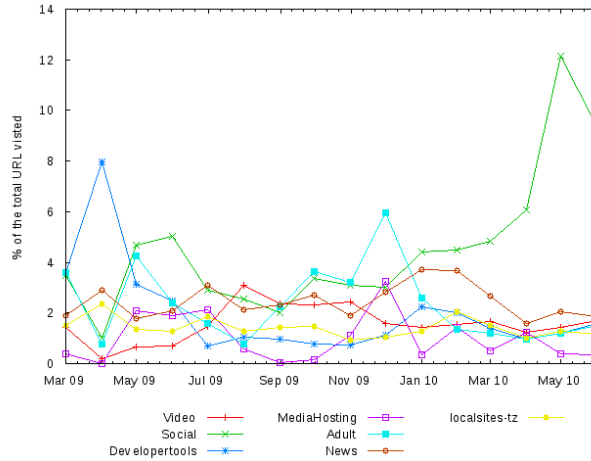
Serengeti pilots is a self sustained broadband Island with its own network services hosted locally, running a domain name, mail, web and VoIP servers. The idea is to facilitate communication within each sector and between sectors at a district level. Current services includes:

- e-Governance: The district website provides various informations to the public. It also provides blogs, forums and chat for exchange ideas and provide feedbacks.
- e-Health: District hospitals providing consultation to connected primary health centres via video-conferencing and VoIP.
- e-Learning: Various contents are captured and stored into the server to be accessed by students and teachers.

Apart from the broadband connectivity locally, there is also a narrowband VSAT connection to the Internet which is used in variate ways as discussed in [16]. Fig. 2 further provides a summary of Internet utilization. Like any other region, the social networks seems popular. Access to local newspapers seems also to increase as times goes on.

### 4.4 Technology

Our model is about sharing of the passive infrastructure at cost-related rate. To connect the 2 districts, we are using a fiber cable provided by the power utility company, in return we offer them an Internet connection. WiFi, which is easily accessible, affordable and require a minimum knowledge and equipments to build and maintain is used in the last mile, connecting the end users as shown in Fig. 1.



**Fig. 2.** Internet Traffic Growth

#### 4.5 Business Model

An ICT Board, registered as a not for profit company, with members from the government, private sector and community representatives was formed. It is a pure PPP model, tasked to oversee ICT matters in the district, including managing the broadband network. By providing services to government institutions (health, education and governance), it was able to raise CAPEX from a development partner, Swedish International Development Agency (SIDA) to build the network.

The OPEX, including technician salary and Internet fees is achieved through contributions from users. Current income, mainly from Internet charges is 2.5M TZS while expenses is 2M TZS.

From their own budgets, the municipalities provide funds to extend the network to cover new schools and hospitals. Also, the PPP model facilitates getting entrepreneurs setting up ICT centers which extends the network, provide basic ICT trainings (capacity building) as well as Internet access points.

## 5 Conclusion

Our approach to stimulate the establishment of sustainable broadband markets in areas of little or no commercial interest has been validated in real pilot networks. The Serengeti pilot discussed in this paper is one of them.

Our main contributions include: 1) the holistic market oriented approach involving all interested stakeholders in a localizable capacity building framework integrating development activities and learning on the individual, organisational and consortia levels in parallel, and 2) the innovative use of leading edge technology to establish a high-performance, low-effect broadband network at a very low cost.

While our approach has developed to a point where we are confident to disseminate it further, we will continue to stimulate and monitor the developments of the pilots, intensify our research on green networks and risk management methods that can attract commercial actors to go into under-served areas in early stages.

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