ANNEX

FORMAT FOR SUBMISSION OF CASE STUDIES ON SUCCESSFUL PRACTICES IN TELECOMMUNICATION FOR RURAL AND REMOTE AREAS

Submission of case studies

The case study submission constitutes of two parts:

- The Case Study Summary Information form (Section A) to be completed, preferably, in electronic format using the template provided
- The Detailed Project Description and Analysis (Section B) to be provided in free text form

The Case Study should be submitted **before 1 February 2007 to:**

BDT Secretariat
E-mail: devsg2@itu.int
Fax: +41 22 7305484

Any queries about the methodology or the meanings of the questions should also be addressed to the **BDT Secretariat**.

Language and length

Reports may be submitted in Arabic, Chinese, English, French, Spanish or Russian; the description and analysis shall be 7 to 14 pages of A4 sized paper single space, according to the categories specified in Section b.

Coverage and technologies used

Case studies normally cover a single telecommunications project in a rural or remote area. It is, however, permitted to base the case study on several **closely related** projects, instead of a single project, provided that the recommended length and format of the submission is respected.

The following projects are solicited:

1. Projects which have been operational for more than six months.

2. Projects completed within the past three years.

In describing the project (s), members are invited to ensure coverage of one or more of the topics of concentration defined in the terms of reference of Question 10-2/2:

- Development of multi-purpose community telecentres (MCT), public call offices (PCO) and community access centres (CAC) and community media centres (CMC);
- Provision of telecommunication services to rural and remote areas;

- Expansion of sound and television broadcasting to rural and remote areas and linkages to MCT's, PCO's, CAC's or CMC;
- Impact of the provision of ICT in rural and remote areas if any, and in previously unserved or underserved urban and semi-urban areas, particularly in furthering the economic, social and cultural development of the area that meets the needs of both women and men in the community.

Welcome examples of technologies, which are especially relevant for use in harsh climatic or geographic conditions of remote and rural areas, such as solar-powered equipment, and/or of development applications such as e-health and tele-education.

A) Case Study Summary Information

1. Title of case study:

Bringing connectivity to rural Zambia using a collaborative approach

2. Details of the person preparing the case study:

Name and title of person preparing the case study: Mr. Gertjan van Stam

Organization submitting the case study: LinkNet Multi-Purpose Co-operative Society

Address: P.O. Box 630 722, Choma, Zambia
physical: Macha, Chief Macha Area, Choma District, Southern Province, Zambia

E-mail: gertjan.vanstam@link.net.zm

Website: www.link.net.zm

3. Status of project(s):

☒ Operational

☒ Completed

4. Location and population of the project area

Location (village, district, etc.) village

Population of the project area 128.000

5. Types of projects

☒ Pilots (trials)

☒ Licensed or authorized

☐ Projects funded by USF

☐ Others

6. Type of application / service (check one or more boxes)

☐ Public voice services

☐ Radio or TV broadcasting

☐ E-governance, e-administration

☒ Support for small business, e-business

☒ E-health

☒ Tele-education, e-learning

☒ ICT training

☐ Disaster preparedness / emergency support / disaster mitigation

☐ Environmental monitoring / protection

☐ Others (please specify) _____

7. **Type of technology** (Check one or more boxes)

☐ Wired local loop: Copper, optical fibre, etc. (customers' loop)

☒ Wireless local loop (customers' loop)

☒ Fixed wireless access (long distance)

☒ Mobile wireless access

☒ Satellite two-way communications: VSAT, etc.

☒ Wireless LANS and IP-based related networks

☐ Terrestrial voice, data, sound or television broadcasting

☒ Satellite voice, data, sound or television broadcasting

☒ Hybrid or combined technologies

☐ Others (please specify) _____

8. Organizations involved in implementing the project:

Co-operative partners of LinkNet Multi-Purpose Co-operative Society

Global Research Alliance, TNO, Meraka Institute, Churches Health Association of Zambia, CDC, Communications Authority of Zambia, Ministry of Health, Ministry of Education, Medical Insitute at Macha, Royal Court Macha, Macha Mission Hospital, Johns Hopkins University, PrivaServe Foundation, Noaber Foundation, and many many others

9. -150 word summary of the project indicating its expected social /economic impacts

The provision of the Internet has enabled local health institutes to operate more effectively and given local people the opportunity to communicate and explore new ideas. It has also created new employment opportunities and spun off several projects including a data entry service and a sunflower farming initiative.

B) Detailed project description and analysis

Please address each of the 7 elements indicated below, providing 1-2 single space pages for each, and treating separately each sub-element (e.g. 1.a.) which is appropriate. Preferably, please provide the description and analysis in electronic format.

1. Overview of project's targets, objectives and financing

a. Brief description of the country/region: geography, terrain, climate, demographics, socio-economic situation,

Macha is located in the southern province of Zambia, 75 km from the nearest town of Choma and 350 km by road from the capital city of Lusaka. The topography of the area is somewhat undulating, primarily open savannah woodland averaging 1100 meters above sea level. The climate is tropical with a rainy season that runs from approximately late October to early April.

The Macha area is populated by traditional villagers, primarily members of the Batonga tribe, living in small scattered homesteads which usually consist of one extended family. There are no commercial farmers or industries in the area. While much of the population is stable, younger adults move to and from the urban areas of the country. The primary livelihood is subsistence farming with maize being the main crop. The staple diet is cooked maize meal supplemented with peanuts, sweet potatoes and leafy green vegetables.

There is an estimated population of 128,000 (c. 2000) within an approximately 35 km radius of Macha. Overall population density in this area is 25 per square kilometre and 50% of the population is under 12 years of age. Other specific data for the local population are not reliable, but country-wide the crude birth rate is 49.5 per 1,000 population with an infant mortality of 107 per 1,000 live births. Average life expectancy at birth is 39 years old due to the prevalence of HIV/AIDS.

The average income for a person in the village is $1 per day. To travel to the nearest town of Choma by bus, it costs approximately $7 and takes about 2 hours to travel the 75 km distance. The money spent on this journey equates to several days' salary for a person in Macha.

There is very limited infrastructure in Macha. There exists a mission hospital, medical research institute and community centre. Clearly, the health institutions require and expect high quality telecommunications services to be able to offer high quality and efficient health care. There are only dirt roads linking Macha to other villages and to Choma, the nearest town. Electricity is available to only a few, privileged people. However, it is unreliable especially during the rainy season when several outages can occur within a single day.

b. Objectives and implementation details of the project applications (basic telephony, e-business, e-administration, e-education, e-health, ICT training etc),

The technical solution for implementing the Internet is simple and customised to the needs of the community – the infrastructure technology is chosen so that it is as cheap and suitable as possible in the local conditions. In summary, the technology includes a very small aperture terminal (VSAT) satellite connection to the Internet, a mains power supply augmented by a small scale power supply, a wireless local area network connection for PCs, a network server and communications tools/ PCs for training purposes.

The up-front investment required for the implementation in Macha was approximately 100,000 Euros which was obtained mainly from an international partner of the medical research institute and donor organisations. With the creation of new jobs, the income generated from outsourcing services and the income generated from the village itself (e.g. from the local medical research institute and hospital), the LinkNet operation in Macha was sustainable after just two years.

Applications are being developed to meet the needs of the local community in Macha – these include e-learning systems for students in the community (for which an implementation strategy has been developed) and e-health applications used by doctors in the local hospital. The provision of Internet access has also resulted in some 'spin-off' benefits through which local people have demonstrated that they can independently use the Internet for meaningful and relevant purposes, thereby empowering themselves.

c. Consideration of indigenous communities, isolated and poorly served areas, small islands and their particular needs and situations.

His royal highness Chief Chikanta, was born and raised in Chief Chikanta's area. He was anointed Chief in 1995 after the death of His uncle, his mother's brother. Chief Chikanta is seen as the wisest Chief who ever ruled the chiefdom. In 2004 he was appointed by his fellow chiefs, and represented them in Parliament. His main goal as chief is make sure that his subjects lives are continuously improved. Chief Chikanta's statement is that better life can come out of Information and Communication Technology, which is the cry of his heart.

Fred Mweetwa grew up and lives in the rural area of Macha, Zambia. He is Executive Director of rural innovations hub Vision Community Center Macha, Station Manager of Vision Community Radio Macha, and Secretary of the Board of LinkNet Multi-Purpose Co-operative Society. He is student at the University of South Africa, via Internet. His interests are history, community development and showing visitors to Macha around in the rural area.

These two gentlemen wrote a paper (published on http://link.net.zm/?q=node/193), and noted the following: Having realised the importance of introducing and promoting Information and Communication Technologies (ICT) in the development of the country of Zambia, the government of the Republic of Zambia came up with an ICT policy1, which was launched March 2007. The main goal of the ICT policy is to integrate ICT in most of the institutions of the sectors of the Zambian economy and develop the nations research or development capacities to support facilitate and contribute to the development of all especially key sectors of the economy including of the appropriate local ICT product and services. In order to realize the goal of the policy, government has put in place commitments, objectives and strategies.

Now a few sectors are highlighted as to illustrate the specific need for ICT development in rural areas.

2 EDUCATION, RESEARCH AND DEVELOPMENT

It has to be recognized that for developing countries like Zambia, to make major progress in social and economic development, there is need to invest significant effort and resources in the

education system2. Zambia's education system in rural areas is currently under resourced, with a substantial section of the population without access to high school and tertiary level education as well as professional training. Therefore, a significant percentage of the population is education attainment required for meaningful contribution to national development.

Against this background, there is great need to integrate ICT in the education system and develop the nation's research and development (R&D) capacity to support, facilitate and contribute to the development of key sectors of the national economy.

At local levels in rural areas, teachers spend a lot of time and money travelling to their district headquarters for either administrative programs or to get their salaries. Such is needed due to lack of proper communications due to lack of ICT facilities or services. They usually come back without meeting their supervisors or without collecting salaries.

There is great need to have Internet at every school to improve on teacher's output and expose pupils to internet at the early stages of their education. This will enhance the research component as it will cover wider and deeper areas of our rural communities and researchers will see the challenges of introducing ICT at grass roots level.

3 CULTURE AND HERITAGE

Access to information through Internet forms the basis for creating an information society. Therefore the availability of 'internet access points' to the members of the communities is as important as the information itself. Development and exploitation of ICT supports rural development, community based initiatives and projects.

Information on our Cultural Heritage is passed from one generation to another by oral means. This means over a period of time, the information could either be misrepresented or misinterpreted or indeed diluted. There is therefore great need to introduce and promote ICT in rural areas to safeguard African Cultural Heritage3, also through the Internet. This was discussed during the Lwiindi Ceremony. Apart from safeguarding our Cultural Heritage, the use of internet in rural areas will enhance our ability to communicate this heritage to the internal communities for their benefit and the social and economic advancement of our country.

The emphasis should be to promote wide spread public access to information through appropriate traditional and new technology solutions based on relevant local content while promoting cultural heritage.

4 HEALTH CARE DELIVERY

The performance of the health care delivery system over the years has been affected by communication problems4. This is mainly due to distances between health delivery points and administrative centre, just like in the education sectors. This draw back has affected the delivery of drugs, messages and date collection/dissemination. Most specialist like doctors, nurses and teachers are confined to the line of rail leaving rural areas to cope with very inadequate staff levels.

It is important to note that the introduction of internet in rural areas will play a vital and effective role in the organization and delivery of heath care health services. The emphasis here will be to improve access to quality health care as close to the family as possible through the development and exploitation of internet and other modern technologies since the existing of communications between health centres and administrative centres are inadequate.

5 AGRICULTURE AND DEVELOPMENT

Agriculture is Zambia's economic backbone5 as it plays an important role in the social and economic development in many Zambian communities. There is need to integrate ICT in the agricultural sector through the use of internet in the planning, implementation, monitoring and the information delivery process.

6 TOURISM, ENVIRONMENT AND NATURE RESOURCE MANGEMENT

The tourism sector constitutes one of the economic pillars of Zambia's economy, this includes both wildlife and no-wildlife tourism.

Over the recent past, Zambia has positioned herself well in the tourism market. By its very nature, the tourism sector is well suited for integration and application of ICT which potentially enhances marketing of tourism products and services, will increase efficiency and effectiveness of transactions, and service delivery. It is therefore necessary introduce internet in rural areas for the development of the tourism industry and facilitate the conservation of our natural resources and Cultural Heritage as well as to protect the environment.

7 MAINSTREAMING YOUTH AND WOMEN ISSUES

The successful penetration of internet with existing social and economic structures depends on its people. Usually in most of our communities youths and women are heavily marginalised. However, in most activities they constitute a very important segment of society. They are actually the majority in all communities. Therefore, there is need to address youths and women as special groups in society that positively contribute to the growth of ICT as as well as the use of Internet as empowerment tools in their daily activities.

It is becoming very clear that we have to use Internet as an instrument to mainstream youths and women issues in most activities of the rural economy and society and to empower youths and women through opportunities created by implementation of ICT projects and programs in the rural areas.

8 TELECOMMUNICATIONS AND SUPPORTING INFRUSTRUCTURE

It is commonly understood that ICT infrastructure encompasses telecommunication networks, radio and TV transmission systems, the internet and other multimedia delivery platforms. It should be generally acknowledged that transmission networks for radio, telephone, TV and internet are the basis for mass media development. This is further enhanced by associated physical infrastructure such as roads, electricity and general utilities. With respect to ICT, lack of reliable, widely distributed and and high capacity date network for data, sound and video has contributed to the low availability and penetration of ICT services as well as cost effective deployment of basic services especially in rural areas.

All this has resulted in inadequate or complete lack of telephone and internet services, high start-up costs and long bureaucratic procedures for radio, especially community radio and TV broadcasting. The major emphasis here is to increase access and promote widespread deployment of ICT services through the expansion of the nation's telecommunication back bone infrastructure covering the remotest part of Zambia.

The opening of Vision Community Radio Macha and internet services offered by LinkNet are efforts which need to be supported by all stakeholders and promoted to enable them expand their catchment areas from Chief Macha, into other chiefdoms such as Chikanta, Muchila, Hachitema,

Mapanza, Shezongo, Singani, Nalubamba, and Moonze. The new catchment area would house more than 65 basic schools and slightly more than 13 Rural Health Centres and 15 palaces.

9 CONCLUSION

This text is initiated by the authors as to build upon the unique knowledge gained before and after introduction of ICT in rural areas. The results have been encouraging and further developments are highly needed. There is a good rational for these developments. Support is solicited for further research and development of ICT in rural areas, also with an angle towards supporting the preservation of African culture.

d. New technologies deployed for providing reduced cost capital and operating cost solutions.

The technical solution implemented in Macha consists of a wireless local area network (WLAN) that is connected via very small aperture terminal (VSAT) satellite connections to the Internet. Computers and other user devices connect to the wireless network to obtain access to Internet services. Wired connections are rarely used because they require more installation effort and are sensitive to physical damage. They are also susceptible to lightning damage.

Further information on (3 a)

Detailed information on the innovative technical solutions are at LinkNet's website http://www.link.net.zm and its wiki http://wiki.link.net.zm

e. Financing and partnership aspects of the project, including the estimated total cost of the project and the types of funders (e.g. sponsors' contribution, charitable donations and subsidies from USF).

LinkNet has developed a precise Master Plan in 2006, which guiding the 'proof of concept' in Macha, the 'proof-of-reproduction' in Mukinge, and further implementations. This Master Plan can be downloaded at http://link.net.zm/files/060220,%20Master%20Plan%20LinkNet_vlq.pdf

The Meraka Institute is a South African national research centre managed by the Council for Scientific and Industrial Research (CSIR). The Institute aims to make a substantial contribution to connecting the 450 million people in rural Africa through research, development and technological innovation, either directly or in association with the Global Research Alliance (GRA). The GRA is the alliance of nine of the world's leading knowledge and technology research organizations. The Meraka Institute has a research mesh network deployed in Pretoria where it is used by staff and a community mesh implementation in Peebles Valley near White River in Mpumalanga connecting various community sites including an HIV/AIDS Clinic, a hospice, other administrative buildings and community members. The Meraka Institute also has a 49 node mesh network lab where it conducts mesh protocol research.

TNO is the Netherlands Organisation for Applied Scientific Research. TNO's aim is to strengthen the innovative power of industry and government. Next to its main activities, TNO strives to contribute to the Millennium Development Goals through its membership of the GRA and its corporate program on development cooperation, in which LinkNet is a partner since 2006. TNO supports LinkNet through knowledge transfer and technical innovations, creating partnerships for implementations, and by studying the local usage of ICT services.

In February 2007, Gertjan van Stam and Adrian Pais of LinkNet, Gerard van Oortmerssen of TNO, and a delegation of the Meraka Institute first met during a visit hosted by the Global Research Alliance (GRA) at the CSIR.

The Meraka Institute became aware of the efforts within LinkNet to implement mesh networking as a more reliable alternative than conventional wireless LAN (WLAN) for extending Internet access to the communities in rural Africa.

Urged by LinkNet's need for support, the Meraka Institute developed a do-it-yourself (DIY) mesh guide called "Building a rural wireless mesh network." It explains how to plan, configure and deploy a wireless mesh network. It is based on the Freifunk mesh firmware (an open source distribution that uses the Optimized Link State Routing (OLSR) mesh routing protocol).

The content of the DIY mesh guide was presented during a hands-on training workshop attended by LinkNet and TNO and hosted at the Meraka Institute in June 2007. The LinkNet team also visited the Peebles Valley community, near the Kruger National Park in South Africa, where a mesh network was implemented during 2005.

The Meraka Institute visited Macha and Mukinge in July 2007, to experience the impact of Internet access in these communities. It was also valuable to see the challenges faced by LinkNet in terms of rural ICT infrastructure provisioning in Zambia. Some of these challenges included: unreliable electricity supply, bad road infrastructure, lack of air conditioning and dust. These factors naturally translate into technology research challenges.

Within one week after the workshop, the LinkNet team was able to set up a mesh network in the rural settlement of Macha in Zambia's Southern Province, providing wireless Internet connectivity to ten buildings of the local hospital. Implementation challenges initially experienced were resolved between LinkNet, TNO and the Meraka Institute and led to improvements in the mesh guide.

The signing of a Memorandum of Understanding (MoU) between LinkNet Multi-Purpose Co-operative Society Limited of Zambia and the Meraka Institute on 17 August 2007 was another significant step towards the creation of low-cost, wireless connectivity in Africa. The purposes of the MoU are to:

- co-operate in research at LinkNet sites;
- create broad awareness of the needs for Internet access in rural Africa;
- strive for development and publication of open source solutions for deployment in Africa;
- develop a Center of Experience on rural ICT development and training in Zambia; and
- develop research projects to gain a better understanding of realities in rural Africa.

The technology research and development roadmap drafted by the Meraka Institute will address the following requirements: to allow the mesh nodes to fully auto-configure and thereby make the mesh equipment still easier to deploy; to allow radios in the mesh nodes to choose the best frequency and thereby reduce interference and increase throughput; to design multi-radio mesh nodes that will obtain higher throughput; and to reduce energy consumption to allow the mesh nodes to operate on batteries and solar power thereby providing a more energy efficient, sustainable solution.

f. Decision-making process to determine the project

The successful implementation of telecommunication services and the Internet in Macha was based on four key enablers:

- A holistic approach involving all the stakeholders including health institutions, schools and community members;
- Training of local people for daily IT operations and on-site support;
- Affordable technology customised to the local environment and;
- Central training and implementation at the LinkNet Centre of Experience at Macha.

The key to the success in Macha was a holistic approach involving all the stakeholders including government, the local community, local institutions, and donor organisations. In 2007, after just three years, there are in excess of 100 computers in Macha, 200 local people have been trained in basic computer literacy, ten locals from Macha have been trained as IT technicians and over 65 new jobs have been created. The IT technicians are not only using their skills within Macha but also contracting their services to institutions in urban areas, bringing in much needed revenue to their families. Additionally, the community has provided data entry services (of thousands of documents) to a company in the developed world. The provision of access to the Internet, coupled with a solid supporting structure, has shown that the local people can empower themselves to improve their lives and create new opportunities for themselves.

2. Infrastructure and regulatory environment

a. Infrastructure components: Pre-existing telecommunication facilities, transport access, electricity supply, distance to the nearest local exchange and/or IP network, human resources, security,

The Internet was implemented by LinkNet in Macha in 2004. Prior to this, the only forms of communication in Macha were by an unreliable high frequency (HF) radio link that enabled short messages (300 symbols per second) to be sent to/received from other towns and a very high frequency (VHF) system for voice communications to Choma, a town located 75 km away. Before 2004, Macha had only a handful of ‘stand-alone’ computers that were not connected to the Internet.

There are no fixed lines or optical fibres connecting Macha elsewhere as telecommunications operators do not view this as a viable business opportunity. Prior to the end of 2006, there were no mobile phone services offered in Macha.

b. Regulatory components: Universal service obligations, licensing conditions, frequency availability (for radio-based projects), other regulatory issues,

As requested by the controller of the Communications Authority of Zambia, LinkNet LinkNet has applied for a free rural communications license with The Communications Authority of Zambia on 8 June 2007. The content of the application is published at http://link.net.zm/?q=node/187

c. Other factors which influenced the operating environment (manufacturers, standards etc).

None.

3. Technical description and services provided

a. Architecture, type of systems, main technical characteristics, frequencies (for radio-based projects), power consumption, performances (capacity, reliability, quality of service), network management, etc.,

The network consist of two VSAT satellite connections, an IT room with a number of servers, switches and routers, and a three layer WLAN 802.11g network to share the Internet connection throughout the community. Each of the layers uses a unique radio channel to prevent interference between the layers. The top layer of the WLAN network, indicated in the figure by dashed lines, is the wireless wide area backbone that interconnects the several wireless local area backbones on the middle layer. The local area backbones are formed by mesh clusters. The bottom layer is the clients' access layer with hotspots, not shown in the figure. Each of the mentioned network elements are discussed in more detail below.

A.VSATs

Two VSAT satellite connections are used to provide internet connectivity to the community in Macha. The first of these is a shared (1:8) C-band VSAT connection with a downlink speed of 1.024 Mbps and an uplink speed of 256 kbps. This VSAT has a committed information rate of 128 kbps on the downlink and 64 kbps on the uplink. The second connection is a Ku-band VSAT connection, which is a shared (1:13) VSAT with a downlink speed of 512 kbps and uplink speed of 128 kbps. This VSAT does not have a committed information rate. Two VSATs are needed for redundancy as VSAT connections go down intermittently.

The problems experienced are often related to the equipment itself and are caused by power instability and bugs in software upgrades. Also the bad roads take their toll on equipment, with more than half of the computer hard disks dead on arrival or failing. Repairs may take up to several months as components are often not available locally and communications are hampered when the communication channel is severed. Experience shows that these shared connections often suffer from traffic overload leading to congestion (low throughput and long delays). The Ku-band VSAT has practically no connectivity during office hours as it does not have a committed information rate. The monthly fees for the two VSAT connections total nearly $1,700 per month. Generally stated, the exorbitant cost for bandwidth and the poor network performance are frustrating the development of rural areas in Africa.

B.IT Room

An air-conditioned IT room hosts a number of standard PCs, routers and switches. The servers are used to provide the following services: gateway, traffic shaping, Domain Name System (DNS), file server, backup server, web server, mail server, authentication and billing. Also the network performance is monitored from this room with the help of some basic network monitoring services. The use of open source software minimises the cost by benefiting from the innovative spirit of the large open source software development community and preventing vendor lock-in.

Administration of network management and customer relation management is all done on the Intranet by using a content management system called Drupal. Network management remains a challenge as the level of IT expertise of most LinkNet employees is still only basic.

A major threat is the instability of the power grid. Regular outages and high peaks damage the power supplies and hard disks of the computers. Power supply backup using batteries is available, but has insufficient quality. Good ICT equipment is difficult or impossible to obtain in Zambia.

C.Wide area backbone

The wide area backbone interconnects the different local area backbones and the gateway server in the IT room with the VSAT connections. In cooperation with the Meraka Institute of South Africa and TNO of the Netherlands, LinkNet is presently working on the development of a mesh network topology with multi-radio routers.

For the time being, however, locally available outdoor wireless single-radio routers with built-in directional antennas are used. These outdoor units create point-to-point bridges from a non-routing switch in the IT room to each of the local area backbones. Different channels are used to prevent interference between the different wireless units, but as there are there are only three channels available in the 2.4 GHz bands, this is a challenge. Physical separation of the antennas is implemented to decrease the interference. Antennas are mounted outdoors on masts or rooftops to create a reliable line-of-sight radio link.

D.Local area backbone

The wireless local area backbones interconnect all buildings in a local area. A local area is typically one customer such as the hospital, the medical research institute, the community centre, or a group of individual houses.

The local area backbones use a mesh network topology. A mesh network is a multi-hop wireless network that maintains communication by hopping from node to node until a destination is reached. It is self-forming and self-healing and provides reliable multi-path connections between nodes in the mesh.

Mesh networking provides many benefits to rural communities that wish to become connected. It is a reliable, easy-to-deploy infrastructure with a significantly lower cost than alternative solutions. Members of these communities can install and operate their own networks.

Linksys WRT54GL routers with the standard omni-directional antennas are mounted indoors. All mesh routers in this backbone use the same channel. Freifunk firmware running the Optimised Link State Routing (OLSR) mesh routing protocol [15] provide the mesh functionality, configured according to the do-it-yourself mesh guide [16] developed by the Meraka Institute. The transmit power of each router is tuned to minimise the interference between routers in this layer.

E.Clients

Desktop clients connect via a cable to the Ethernet interface of the mesh routers in the local area backbone. The mesh routers run Dynamic Host Configuration Protocol (DHCP) on the Ethernet interface to provide an IP address for the clients. Wireless access directly to the wireless mesh backbone is not supported as it significantly lowers performance. Where wireless access is needed, a wireless access point is connected to the same Ethernet interface. This access point, often a Linksys WRT54G router with DD-WRT as firmware, is configured in bridge mode and forwards the DHCP addresses from the mesh router to the wireless client.

b. Installation and deployment: network planning, subscriber management, etc.,

Working in rural areas has challenges that are not often encountered in urban areas. For example, the number of computers that have parts damaged by power interruption is high. The power problem is just one of the many problems that need further research. Other problems are constant hard disk failures, the high cost of the VSAT connections for Internet services, bandwidth and network management and the lack of a viable billing system.

Some of these problems require unique research that will lead to lasting and cost effective solutions. Long term, on-site operational research will clarify the real issues and provide answers that are suitable for the environment.

Analysis of each individual challenge will illustrate how it affects the daily operations of ICT infrastructure at LinkNet.

A. Electricity problems

Rural areas are prone to power interruptions. This causes damage to computers, the Local Area Network (LAN) as well as the Wireless LAN. Equipment either fails or the connection fails to resume normal operation after power failures. Restarting the Access Points by turning power off and on resumes normal operation.

However, equipment often gets damaged by power failure. The most affected are:

- Power supplies,
- Hard disks,
- Routers,
- Motherboards, and
- Memory sticks.

High temperatures and frequent outages shorten battery life of uninterrupted power supplies (UPSs) considerably. Replacement batteries are often not available in country. Because of this, car batteries were used to replace the original UPS batteries. However, the UPSs were not able to fully charge the car batteries. This is presently being investigated further.

Hard disks do not last long in a rural area such as Macha. Many factors contribute to this problem, including damage during transportation and power failures. The high temperature and dust are also likely causes for hard disk failures.

As most equipment is re-furbished and old, affordable hard disks are difficult to source.

B. VSAT connection cost

In rural areas, people normally do not earn as much as those that in urban areas. Thus they have less money to spend on leisure. For some, the Internet is seen as such a service; just another form of leisure. And thus they would not even dare to put their money into it. Given a chance, these very people are willing to explore and learn what ICT is all about. They are willing to explore only if they feel it is affordable. Locals often come to Vision Internet Café (an Internet Café incorporated by LinkNet Zambia) with the desire to use the Internet for the first time. When the charges (per minute) are made known to them, they choose not to use the service. They do this not because they do not want to, but because they do not find it affordable.

Unfortunately, the cost for an Internet connection (which is via VSAT connections) is more expensive in rural areas than in cites. Cities normally have higher densities of subscribers, which in turn reduces the effective cost for each Internet subscriber. Unlike their rural counterparts, Internet users in urban areas also have other resources such as libraries that they can use. Very few rural areas have good libraries.

In Macha, the total throughput for the entire village from the two VSAT connections is approximately 1.5 Mbps, costing an exorbitant $1700 per month. By contrast, in developed countries, a single user might enjoy as much as 7 Mbps using an ADSL connection for only $40 per month.

This brings an interesting issue to light; how can connection costs of a satellite link be reduced to cater for people that cannot afford the high costs that are currently demanded from rural areas? It is only when low cost connectivity is available that we can say, 'Internet is ...information for all'.

C. Bandwidth and network management

Monitoring of both the LAN and WLAN is a very crucial part of computer networks. ICT technicians/administrators should know exactly what is going on from information that is gathered from the network. The relevant information can help ICT experts employ ways that would help improve quality of service to the customer. It can also lead to a more secure and stable network.

However, finding viable tools to help monitor the current network setup at Macha is not easy. Most open source tools require a level of expertise that LinkNet has not reached yet.

Is a cost effective and long lasting solution possible? One that local people can manage? How about traffic shaping for the entire network? How can specific users be assign maximum bandwidth limits? How about Firewalling and SPAM filtering?

These are areas that require special attention to find viable solutions for networks like the one currently existing in Macha.

D. Billing for services offered

In order to maintain services, customers should contribute to the overall development and operation of the service by paying for what they use/get.

Finding a lasting, accurate and stable solution is important as simple mistakes can ruin the relationship between customers and the service provider. No customer would want to be billed wrongly. A customer would want to pay for what he/she has used.

An accurate system that is able to determine how much the customer owes is essential. A pre-paid system is one that is especially useful in rural areas as customers can pay in advance for what they use. If a customer exceeds the limit of allowable access (e.g. volume of download or the time of usage), the system automatically cuts the customer from the service after a warning has been communicated to him/her.

c. Interconnection to national networks/backbones,

LinkNet uses VSAT technology for interconnection to the Internet.

d. For each service delivered (POTS, “IP telephony”, etc.): mode (data type and bit rate) and quality (voice quality and bit error rate).

Two VSAT satellite connections are used to provide internet connectivity to the community in Macha. The first of these is a shared (1:8) C-band VSAT connection with a downlink speed of 1.024 Mbps and an uplink speed of 256 kbps. This VSAT has a committed information rate of 128 kbps on the downlink and 64 kbps on the uplink. The second connection is a Ku-band VSAT connection, which is a shared (1:13) VSAT with a downlink speed of 512 kbps and uplink speed of 128 kbps. This VSAT does not have a committed information rate. Two VSATs are needed for redundancy as VSAT connections go down intermittently.

4. Cost aspects

a. Cost of the equipment, cost per line and cost of the operation of the system,

The LinkNet Master Plan has a detailed breakdown of all costs aspects, and a multi page financial update of this plan has also been produced. Further information in the Master Plan, downloadable at http://link.net.zm/files/060220,%20Master%20Plan%20LinkNet_vlq.pdf

b. Cost of each terminal and cost of the service for the user.

(see a)

5. Effectiveness and sustainability of the project

a. Effectiveness and benefits of the project for the targeted user groups,

Internet has been provided in rural Macha by LinkNet since 2004. The technical solution is simple and customized to the needs of the community – the infrastructure technology is low-cost and appropriate for the local conditions. It includes very small aperture terminal (VSAT) satellite connections to the Internet, a mains power supply augmented by a small scale power supply, a wireless mesh network, a network server and connections for PCs.

Internet in Macha is provided to local research institutions, the hospital and to schools. Individuals can access the Internet in a public internet café or by a connection at home. The most important usage of the internet is personal communication via email and chat with friends and family outside, but also inside the community. Furthermore, the provision of Internet connectivity to the Macha community has yielded several innovations that were not anticipated when the Internet was first introduced. These innovations have led to significant socio-economic benefits.

The successful implementation of telecommunication services and the Internet in Macha was based on four key enablers:

- A holistic approach involving all the stakeholders including health institutions, schools and community members;
- Training of local people for daily IT operations and on-site support;
- Affordable technology customized to the local environment and;
- Central training and implementation at the LinkNet Centre of Experience at Macha.

Working in rural developing areas has challenges that are not often encountered in other parts of the world. The main challenges are power instability and the damage it causes to electrical equipment, malfunctioning computer hardware due to transport and harsh local environmental conditions, absence of local hardware suppliers and exorbitant satellite connectivity costs.

International collaboration has been established. With its partners, LinkNet addresses the main challenges through applied research and innovation, and targets an up scaling of its activities throughout rural Zambia and beyond.

b. Profitability of the project and/or its contribution to local entrepreneurial activities,

(see 6c)

c. Specific strategies to respond to the needs of women, youth, handicapped, indigenous people and other marginalized or socially disadvantaged groups

LinkNet intents to contribute to all aspects of the community, as it reflects the positive element of productivity. Partly in the economic sense: contribution to the prosperity of the community and LinkNet. But also in a less material meaning, such as contributions to family, and the direct environment.

LinkNet strongly believe that people seek for meaningful contributions in life: to things 'higher than self'. Such things can be found in a wider involvement in the community. Thus LinkNet strives to create a diverse environment

The culture states that part of learning comes from other cultures and people that may offer a great source of creativity and wisdom. LinkNet wishes to incorporate a wide range of individuals from different communities, tribes and countries, in order to learn more.

Also, LinkNet seeks for potential among today's less fortunate people, as the organization recognizes that less fortunate people - like people with low educational backgrounds, feeble health, handicapped, or poor living conditions - are by no means without potential. Breaking through their stigma may help integrate them in the working process.

LinkNet acknowledges the extra time investment that may be required to help such people integrate into the organisation, but within the reasonable limits of its capacity LinkNet aims to recruit at least 10% of our workforce from these groups.

d. Aspects of the project, which could be strengthened to enhance its effectiveness or sustainability maximizing the benefits of telecommunication infrastructure in rural and remote areas.

The whole project breaths these aspects.

6. Social and human development impacts

a. Overview of key social and human development needs of the population in the project area,

(see 1c)

b. Role and commitment of the project to addressing these needs,

(see 1c)

c. Socio-economic benefits for, and impacts on the community(ies) and/or at a wider level, including support for gender equity, promotion of community participation and the needs of marginalized and disadvantaged populations

LinkNet sees the provisioning of Internet connectivity as a pre-requisite for the development of rural areas. Subsequently, after introduction of the Internet to the Macha community, several unforeseen innovations occurred. These innovations have led to significant socio-economic benefits. This section presents three case studies on tangible benefits that have been observed as a result of Internet connectivity.

The first case study discusses the introduction of sunflower production in Macha, while the second case study discusses a data entry service provided to a company in the USA. The final case study discusses the tangible benefits of using ICT in the fight against HIV/AIDS and other infectious diseases.

1.Sunflower farming

After only a few months of introducing the Internet to Macha, a farming innovation occurred as a direct result of access to new information and ideas through the Internet.

Fred Mweetwa is a young person who was born, grew up and educated in the rural Macha community. At his workplace, the Vision Community Centre Macha, he has access to the Internet [21]. In mid-2005, only a few months after Internet was made available to the Macha community, he independently searched the Internet for new ideas on farming and came across information on sunflower production at two websites.

Based on the information he gathered from the Internet, Fred started preparing his land for sunflower production. This land is located within the Macha chiefdom in an area where title deeds are non-existing. It has been used by Fred Mweetwa's family for many years. Previously, only maize or ground nuts have been grown in these fields, with varied yields.

In December 2005, a total of 20 kg of sunflower seeds were bought and planted in two fields of approximately 25 by 100 metres for the 2005-2006 growing season. Fred employed ten people on a part-time basis to weed and tend the plants in line with specific information given on the Internet.

In May 2006, Fred Mweetwa and his team harvested the sunflowers, resulting in 70 bags of sunflower seeds, each with a weight of 50 kg. These seeds were then pressed to yield approximately 3 litres of cooking oil per 20 kg of sunflower seeds. The oil was then bartered for maize to feed the entire Mweetwa family during 2006. This family consists of the parents, four children and five other relatives. The barter rate was 750 ml of oil to be exchanged for 10.5 kg of white maize.

Some cooking oil was sold for ZMK 5000 (equivalent to $1.50) per 750 ml. This money was used to cover investments for the next growing season in 2006-2007. The demand for this cooking oil in the community has noticeably exceeded the supply.

After pressing the sunflower seeds to extract the oil, sunflower cake (residue) remains. Fred uses this cake for supplementary feeding of his fifteen pigs and also sells some of it in a nearby town, Choma, for ZMK 12,000 per 10 kg.

During the farming season of 2006-2007, sunflower production has increased ten-fold.

2.Data entry services

The availability of human resources coupled with the availability of the Internet, the drive to explore new business opportunities and the involvement of local community leaders has led to an innovative project in which the Macha community provided data entry services for a company based in the USA.

The project was branded "Macha Conversion Project" was done for a USA-based company. The project involved entering information from 700,000 documents into fields to be fed into a database. The work was done entirely through the Internet. The documents were retrieved from

the company's server in the USA using a web browser. The project was conducted in two separate phases:

The first phase was a 'test phase' to demonstrate whether the people in Macha could provide the desired quality.

The second phase was the execution of the remainder of the work.

Project management in Macha was performed by two people from within the local community, who were trained with relevant skills and knowledge. Approximately 20 workers were involved in entering the data, working in shifts for 24 hours per day.

After a successful first phase, in which 383,838 documents were entered by 20 workers, the USA-based company decided that all the documents should be done in Macha. The project ended after all 700,000 documents were done. During the execution of the project, the Macha project team published performance graphs in a web-based Content Management System (CMS) so that all stakeholders could assess progress on a daily basis.

This project brought hope and aspiration to the people of Macha. School leavers gained invaluable work experience and brought in much needed revenue to Macha. The project demonstrates that rural Africa can competitively do business with other parts of the world.

3.Fight against HIV/AIDS and other infectious diseases.

The fight against HIV-AIDS can be augmented with improved quality of HIV Care, Prevention, and Treatment through locally sustained deployment of health communications, clinical, and management information systems. These services are essential for quality sustained care in poorly connected remote locations.

This improvement is achieved though the deployment of the ICT (Information and Communications Technology) services in Macha's hospitals and the community, increasing the volume of people receiving care and preventive services, and improving the quality and sustainability of the health system.

Tangible results in clinical care

The proof-of-concept in Macha Rural Hospital has shown that telecommunication services are crucial for a remote health care site with an anti-retroviral therapy (ART) clinic.

Since its conception in early 2005,

approximately 2,000 HIV positive people now visit the ART-clinic regularly, and

approximately 1.000 people have been supported with ART.

However, the total number of people with HIV receiving palliative care from the hospital is many times higher. The sheer possibility of adding such numbers to an already stressed hospital schedule of activities requires this improved infrastructure to assure that efficiency and quality are maintained.

In Macha Rural Hospital, at each stage of implementing, sustaining, and improving the quality of HIV/AIDS care, the availability of ICT services and expertise has been essential and is often crucial. This is equally true in dissemination of reports on HIV/AIDS care provisioning.

As a result of this capacity in Macha, several focused expert visits were arranged with direct results. The implementation of CD4 testing equipment would have considerably delayed if communications had not been available. Locally trained ICT experts support electronic patient information recording systems to improve ART treatment support and referral systems. Locally identified and trained rural community members are instrumental in data entry and keeping ICT hardware and software going, on a daily basis in these more logistically challenged remote areas, where 'information highway' access is often the only practical road.

In addition to these primary applications, less extensively trained and less experienced clinical talent has been able to tap into health expertise via telecommunications resulting in information-based decisions, thereby improving the quality of care and treatment. Additionally, it appears that simple access to email communications in remote locations is beneficial to the retention of mid-level providers are assigned to work in remote areas.

Also, in Macha the availability of communications with the outside world (and particularly, Lusaka) assures steady access and supply of HIV/AIDS medicine and a tedious logistical process which is dependent on timely communications and interaction. On several occasions in past years, steady flow of medicine could only be maintained by direct intervention, in a manner made possible only with the ICT infrastructure.

d. Means foreseen to enhance the project's future contributions to human and social development.

Experiences in Macha and other rural areas have shown that ICT plays a pivotal role in the development of a rural community. Such development can only take place when all stakeholders participate in the process. LinkNet has ensured such participation as it is set up as a co-operative and open society, owned by local rural institutions, and located in - and thus part and parcel of - the rural environment.

Local people from rural areas are leaders in LinkNet. They are trained to implement and maintain their local networks. Further study on the drivers, motivators, and nucleons of success is needed. LinkNet is committed to do so, and provide for a stream of reports on its website, initiated from the rural area of Africa.

The next step is a proof of reproduction, further strengthening, extending and solidifying relationships. African development will be fostered and local program management implemented. To solve the major constraints mentioned, pinpointed and well defined projects will be set up in 'a living laboratory' that Macha is providing. For this, Meraka, TNO and other Global Research Alliance members, and international donors have pledged their support.

Technical and operational research based and executed in African rural areas is sought, as only then a complete understanding of the environment can be appreciated.

LinkNet aims for innovations that are usable, originating from within the African rural areas. For instance, one could look at the current show-stopping status quo on bandwidth prices. Innovative ways of addressing bandwidth issues, and its financing are in short supply. Africa needs dedicated, good quality, and free Internet connectivity, at least on-par with empowered Western societies. This is especially needed for special interest groups in health, education and community development. The benefits of free Internet access for the development of Africa could outstrip

costs. Full understanding of technology and other hurdles for rural areas are being studied and used to implement connectivity to those who need access the most. Considering a single issue such as the HIV/AIDS pandemic, innovative financing options are being envisaged.

All these initiatives are supported by committed, international organisations like the Meraka Institute from South Africa, TNO from the Netherlands, and Global Research Alliance partners around the world.

7. Other observations

a. Unexpected results and lessons learned

See http://www.link.net.zm

b. Anticipated near/long-term project challenges and reorientation.

Apart from technical challenges which are dealt with 'on the fly' in the cooperative approach, currently acquiring the necessary funding for building of buildings and other supporting infrastructures at the Center of Experience in Macha is the biggest challenge.

c. Additional information considered useful

The Internet in Macha is provided to institutions such as the medical research institute, the hospital and schools. Individuals can access the internet in a public internet café or by applying for a connection at home. Connections at home are mostly used by teachers, hospital staff, researchers, and in the guest houses for international visitors. A study on Internet usage revealed that the most prevalent use of the Internet is personal communication via email, browsing and chatting. Other usage by community members includes e-learning, buying goods such as second hands cars from Japan, improving knowledge on agricultural techniques and acquiring education material

Interviews with local community members were conducted in a study on the use of Internet in rural Zambia. Some of the findings of these interviews are discussed in the following sections.

A.First use of the Internet

The interviews started with asking people to tell us their story about the first time they used the Internet. In the African culture, where people are used to telling stories, this approach worked very well. The participants who have used the Internet started using it between 2003 and 2005. Most participants first used the Internet in the Internet cafe at the vision community centre in Macha, while others used it in Choma, Lusaka or abroad. Some people were helped to get started by their friends, children and other relatives; others were assisted by people working in the internet cafe. The desired to send e-mails to relatives and friends was a strong trigger to start using the Internet.

“My enthusiasm to use Internet was driven by a Canadian young man who stayed with me and encouraged me to open up an e-mail address so that we could communicate when he leaves for Canada. This prompted me to open an e-mail account.”

Education is another important trigger to start using the internet. A lot of participants look up information for their assignments, for example for the Zambia Open University. Others follow e-learning courses at institutes abroad.

“I am studying at Zambia Open University. Internet has really helped me to acquire information for my school assignments as libraries are very scarce here”

Chatting was another trigger:

“These guys were doing a lot of chatting with people from Australia, America, New Zealand, people from all over the world”. They would type and then click on enter and those guys would reply immediately. When I was watching I was very surprised as to how it worked. So they also opened an account for me at Yahoo and I started chatting and also sending e-mail”.

B.Keep on using the Internet

After their first introduction to the Internet, all participants kept using the internet. Some do so regularly. They browse websites to look up information for studies, on how to use Linux, how to repair cars, farming, news and weather reports (used by the airport manager). People buy books, school materials and even look up prices and buy second hand Japanese cars. Next to information, they establish new contacts with people all over the world, just for fun, but also to exchange information and consult experts on certain topics such as the ones mentioned above. Also, some use the Internet to send reports to donors and supporters of schools in other countries.

“Since then, I use Internet twice a week; I do this after knocking off from work”.

“Apart from studying on line, I also use Internet to communicate with my children based in the United States of America and friends through out the world”.

“I am still using the Internet on a daily basis; this gives me an opportunity to communicate with my friends in Germany”.

Others do not use the internet very frequently, mainly because of the distance between the Vision Community Centre and any other area where they can use the internet. All of these participants expressed the wish to have the Internet at their homes or workplaces.

“At the moment I do not use Internet regularly … it is a 30 minutes walking distance to the community centre where Internet is accessible. My wishes are to have Internet connectivity at our school but the major barrier is the absence of power at our school”.

C.How the Internet changes lives in rural areas

Unanimously, participants state that the Internet changed their lives. For some the impact is still little, but for others the Internet greatly changed their lives for the better.

“To me, Internet has changed my way of life because I would not be the way I am now without it. I am now able to study online and also communicate with friends around the world”

“Internet has changed my life in terms of communication because before Internet arrived at Macha, I used post messages through the post office; this took time to receive a reply if the information was urgently needed”.

What is very interesting is that the Internet also has an impact on the lives of those who don’t use it themselves, such as students getting better quality information from their teachers and farmers learning new things from each other:

“In 2005 I was searching for conditions necessary for sunflower growing. I found the information in the internet. So I went to buy the seeds and planted the sunflowers. Last year I had a successive harvest and this year I’m looking forward to a successive harvest as well. It changed me as an individual, but also the community. One of my friends and also a teacher started growing sunflowers and others have started planting the sunflowers, they followed my footsteps”.

In this case, internet access led to the introduction of sunflower farming [21] and turned out to be a very good way to generate income.

THANK YOU FOR YOUR COOPERATION

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