Rural Access:
Options and Challenges for Connectivity and Energy in Ghana

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A study carried out for the International Institute for Communication and Development (IICD) and the Ghana Information Network for Knowledge Sharing (GINKS) by Jonnie Akakpo, Consolidated Solutions Limited (CSL)

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Contents

List of Abbreviations and Acronyms

DSL	Asymmetric Digital Subscriber Line
AOL	Africa Online
AOL	America Online
ARO	After Receipt of Order
B2G	Business to Government
BoG	Bank of Ghana
BRI	Basic Rate Interface
BUC	Block Up Converter
Busy	BusyInternet
CAN	Customer Access Network
CBLit	Community Based Libraries and Information Technology
CDMA	Code Division Multiple Access
CEPS	Customs Excise and Preventive Service
CIC	Community Information Centre
Cisco	Networking Academy
CSSSPS	Computerised Senior Secondary School Placement Service
DSL	Digital Subscriber Line
FTP	File Transfer Protocol
GCMS	Ghana Customs Management System
GCNET	Ghana Community Network
GHC	Ghana Cedi
GHP	Ghana Pesewa
GINKS	Ghana Information Network for Knowledge Sharing
GISPA	Ghana Internet Service Providers Association
GIX	Ghana Internet Exchange
GPRS	General Packet Radio Service
GT	Ghana Telecommunication Company
GWh	Gigawatt Hours
HDSL	High-speed Digital Subscriber Line
HIPC	Highly Indebted Poor Country
IDN	Intercom Data Network
IDU	Indoor Unit
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
IXP	Internet Exchange Point
JHS	Junior High School
JSS	Junior Secondary School
Kbps	Kilobits per second
KNUST	Kwame Nkrumah University of Science and Technology
LAN	Local Area Network
MoF	Ministry of Finance
MOTI	Ministry of Trade and Industry
MTN	Mobile Telephone Network
MRTG	Multi Router Traffic Grapher
NCA	National Communication Authority
NCS	Network Computer Systems
NHIL	National Health Insurance Levy
ODU	Outdoor Unit
POP	Point of Presence
POS	Point of Sale
QoS	Quality of Service
SAT3	South Africa Telecom 3

SAT3/WASC /SAFE	South Africa Telecom 3/Western Africa Submarine Cable/South Africa Far East
SHS	Senior High School
SLA	Service Level Agreement
SMS	Short Message Service
SOHO	Small Office or Home Office
SSS	Senior Secondary School
TAPCO	Takoradi Power Company
TICO	Takoradi International Company
TL 9000	A quality management system designed specifically for the Telecommunication Industry
UPS	Uninterruptible Power Source
USD	United States Dollar
VAT	Value Added Tax
VCI	Virtual Identifiers
VPI	Virtual Path Identifiers
VRA	Volta River Authority
WAEC	West African Examinations Council
WiFi	Wireless Fidelity, a wireless technology brand intended to improve the interoperability of wireless local area network products
WiMAX	Worldwide Interoperability for Microwave Access

Purpose of this report

This report was commissioned by the International Institute for Communication and Development (IICD); an international, not-for-profit, non-governmental organisation (NGO) that assists people in developing countries to create practical and sustainable information and communication technology (ICT) solutions that connect people and enable them to improve their livelihoods and quality of life.

It is part of a wider initiative by IICD to prepare a series of reports about connectivity and Internet access in rural areas with its partners in Zambia, Tanzania, Ghana, Uganda, Burkina Faso, Mali, Ecuador, Bolivia and Jamaica. The purpose of this report is to enable organisations engaged in rural development to make informed decisions about rural connectivity and Internet access in Ghana.

Executive Summary

This report is a study on Internet connectivity and energy situations in rural communities in Ghana. Methods used include face-to-face interviews, telephone discussions, e-mail and a desk review.

Results of the data that was analysed revealed that the majority of Internet Service Providers (ISPs) in Ghana are located in the capital city, Accra. A few service providers have a presence in one or two regional capitals and mining communities around the country. A few others provide Wide Area Network connectivity via Virtual Private Networks to banks with branches dotted around the country.

The study identified that a rural community in Ghana is a deprived community which lacks telecom infrastructure, electricity and sometimes appropriate buildings. It is also a community with less than 5,000 inhabitants whose preoccupation may be largely agricultural. It further revealed that the absence of meaningful economic activity and skilled personnel make these locations unattractive for investors.

The study also revealed that Ghana has an electricity supply deficiency following long periods of erratic rainfall which causes the hydro plant that generates the bulk of the country's energy requirements to dry up. Renewable energy sources such as solar energy, wind and biomass are not well-known and have not been exploited yet, but are considered potential sources to supplement hydro power generation and have been discussed.

The report finds that the status of Internet connectivity and energy in rural Ghana is not very encouraging. Recent developments within the sector, however, with funding support from the Chinese Government and the World Bank to facilitate the extension of a fibre optic network throughout the entire country, as well as addressing the energy shortfalls, hold high promise for the country and give reason for excitement.

The next couple of years will witness developments in the ICT landscape and this guide is intended to provide some insights into the critical issues of Internet Connectivity options, Internet applications that can be deployed, chargeable rates, opportunities for strategic partnerships, and renewable energy sources.

The report is an evolutionary document and future revised editions will continue to address many more issues that will be of significant interest for the development and growth of the industry.

A Historical Perspective on Connectivity

The first international computer network in Ghana was based on store and forward e-mail and bulletin board systems in which computers were linked through short dial-up calls. A Fidonet connection was established between Greennet in London and the Ghana National Scientific and Technological Information Network (GHASTINET), the Association of African Universities (AAU), and the Technology Transfer Centre (TTC) in 1989.

The project started out as a pilot of the Pan African Development Information System (PADIS) and was funded by the Canada-based International Development Research Centre (IDRC). The National Science and Technology Library and Information Centre (NASTLIC) of the Centre for Scientific and Industrial Research (CSIR) assumed responsibility for operating GHASTINET. Later, the Balme library at the University of Ghana became the central Fidonet hub for an extensive network that at its height supported 50,000 users.

A more robust store and forward e-mail system was built by the Association of African Universities (AAU) using the Unix-to-Unix Copy Protocol (UUCP) a few years later and this was to provide e-mail connectivity to twenty-three organisations, including the three main universities in Ghana: the University of Ghana, Kwame Nkrumah University of Science and Technology, and the University of Cape Coast.

The Association of African Universities' e-mail system, AAUnet, allowed subscribers to route e-mail traffic to the global Internet before Transmission Control Protocol/Internet Protocol (TCP/IP) connectivity was first provided by a commercial system integrator, Network Computer Systems (NCS). Network Computer Systems applied to the Ministry of Transport and Communications in 1992 for the right to offer value-added services such as e-mail. Originally, NCS was a user and reseller of MCI Inc[1] mail, but by 1994 NCS had established a 9.6 kbps Point-to-Point Protocol (PPP) connection over a dial-up link to Pipex, the largest ISP in England. Network Computer Systems allowed its subscribers to dial-in to its computers, establish a shell account and access the global Internet during the four to six hours a day when the connection to Pipex was up. Dr Quaynor applied for, and in January 1995 received, permission from the Internet Assigned Number Authority (IANA) to use and administer the Ghana Domain name ".gh".

By August 1995, NCS had purchased a 14.4 Kbps leased line from Ghana Telecom so that it could establish a dedicated TCP/IP connection with Pipex. It was then able to offer its clients World Wide Web (WWW), File Transfer Protocol (FTP), Telnet, and other Internet services on a 24/7 basis. By 1995, NCS had opened Points of Presence (POPs) in Kumasi and Takoradi. As the number of clients grew, NCS expanded its dedicated connection to Pipex to 64 Kbps.

In 1995, NCS also applied to the Frequency Board for permission to operate its own international gateway based on satellite technology. It received permission to operate a satellite connection and, in 1996, implemented a 3.8 meter class C satellite connection over which it was able to connect to the Internet backbone in the United States.

By June 1996, a second ISP, Internet Ghana, was up-and-running. It was established by Electromod, a local computer company run by Leslie Tamakloe. For international connectivity, Internet Ghana connected to the MCI Internet backbone in the United States via a 64Kbps dedicated connection leased from Ghana Telecom, running over Ghana Telecom's Nkuntunse 40 meter international earth station. Internet Ghana focused on developing corporate customers and worked with Ghana Telecom to provide access to customers via ISDN. Internet Ghana served approximately 20 corporate customers in 1996.

The number of corporate customers grew to about 40 in 1998, 60 in 2000, and 84 in 2003. The company focuses primarily on corporate clients, but does provide connectivity to CSIR and the Ministry of Health. Internet Ghana pioneered the use of DSL (Digital Subscriber Line) in Ghana and by 2003 was supporting approximately 150 subscribers on DSL over existing phone lines. These customers use a splitter to allow them to access both voice and DSL over the same line.

As the number of subscribers grew, Internet Ghana upgraded its connection to the Internet backbone to 256Kbps. By 2000, Internet Ghana was operating its own 2 Mbps satellite connection to the global backbone. In 2002, Internet Ghana purchased an additional 2 Mbps of connectivity through the SAT-3 submarine cable that runs from Portugal around South Africa to the Middle East.

[1] An American telecommunications company that was headquartered in Ashburn, Virginia.

Ghana's third ISP, Africa Online, was founded by three Kenyans who had studied at the Massachusetts Institute of Technology (MIT) and Harvard University in the United States and returned to Kenya to found an Internet service for all of Africa. The company received significant funding from Prodigy. In November 1996, Africa Online, led by Ghanaian MIT alumnus Mawuli Tse, opened up service in Ghana using a 64Kbps Ghana Telecom leased line to its hub in Boston. After several months, this leased line was replaced with an earth station that provided 512 Kbps of international backbone connectivity. Africa Online also used VSAT to build a Ghana backbone of 2 Mbps that connected many of the regional capitals including Tamale. The dot com crash and the drying up of funds from Prodigy forced Africa Online to cut back many of its forays into the value added market. The company decided to focus on providing a high quality service sold at a premium.

Between 1999 and 2007, Ghana's National Communications Authority (NCA) registered over 52 ISPs, of which 16 started operation (Table 2). The NCA gave many of the new ISPs licenses to operate their own international satellite gateways.

(Source: *Global Diffusion of the Internet: The Internet in Ghana* by Forster, Goodman, Osiakwan and Bernstein.)

Rural Connectivity: The Challenges

The challenges

There are many challenges that exist with rural connectivity in Ghana. Below are only a few of the challenges that are being faced by people who are trying to have connectivity in the rural areas. Ghana Telecom is the main infrastructure provider in Ghana and only covers the major cities. You will hardly find any telecommunications facility in the rural areas. The only way to reach the rural areas is perhaps to connect using a Wireless infrastructure and/or a VSAT. Rural areas with coverage are areas that have mobile coverage and Ghana Telecom's Fixed Cellular Terminal (FCT). The FCT acts as a fixed line facility but picks up GSM signals of the incumbent's Onetouch GSM service.

Last Mile Infrastructure

Last mile access is distributed between dial-up access (often limited to 24Kbps), leased line connectivity (primarily 64Kbps), and wireless access. Internet Ghana successfully used DSL to connect companies and is currently being used by many companies. Although the pervasiveness of wireless and DSL access potentially should improve connectivity, these are underutilised because of the limited, low quality infrastructure. Access methods are less prevalent in the rural areas. Wireless networks are the most common and popular ways to connect in the rural areas but these are still private initiatives.

Cost of Service

The cost of buying bandwidth in Ghana is high and the cost of buying satellite bandwidth is even higher. This makes it an expensive venture to try to send Internet to rural areas since there is lack of last mile infrastructure and other facilities. The cost of Internet and International services in Ghana is better compared to other countries in the African context. The SAT3 fibre which runs along the West coast of Africa costs a GISPA-registered Internet Service Provider $4,050 per a Mbit. Its satellite equivalent costs $5,500. Today, the average cost of 20 hours of Internet use is $20, compared to $60 which used to be the case some six years back. Dial-up and broadband are three times cheaper than they were in 2001 and the cost of International Services has also been lowered. The following table summarises the cost figures of the Internet and International Services in Ghana.

Table 1: Affordability of Telecommunication in Ghana[2]

		2001	2008
I	Local Call cost	$0.21	$0.054
II	Call to US cost	$1.5	$0.5
III	Internet Access Cost	X 3	Dial-up $25-$35 per month/ $100-$120 per year Broadband: Average Installation fee: $120 plus Subscription fee of $65 per month
IV	Average Cost of 20 hours of Internet Use (cyber café)	$60	$20
V	Price of full circuit (to US/UK) SAT3	$12 000	Non-GISPA - $8,000 Non-ISP -$12,000 GISPA members - $4,050
VI	Average Satellite Price (1 Mbit) – duplex	$15 000	$5,500

Availability of Electricity

The lack of a steady, reliable power supply from the Electric Company of Ghana is one of the main challenges affecting rural connectivity. In some cases, there is lack of electricity generation. In other words, to send connectivity to such areas it is imperative to buy a generator at an extra cost.

Lack of Capital

The lack of capital to secure cost-valued consumer and professional electronic equipment into the infrastructure of networks, thus making them reliable resources to the community, is also a challenge.

[2] Source: Ministry of Communications

Plans to improve access in the rural areas

There are various plans to improve access in the rural areas of Ghana. Government, in partnership with the operators, is spreading the Internet to all ten regions and has further plans for rural connectivity. Other private initiatives are in place to augment the efforts made by government.

The Community Information Centre Initiative

The Community Information Centre (CIC) Initiative of the government aims to send Internet facilities to the 230 constituencies of Ghana. The Community Information Centre initiative will create rural access centres and use the medium of ICT to promote community-based ICT applications that will promote operational efficiency delivered through the effective and timely availability of information.

The government's goals of 'universal service and access' as set out in the National Telecom Policy are being pursued. In 2005, the government began a number of initiatives in this direction. The construction of Community Information Centres was part of the government's commitment to promote an all-inclusive information and knowledge society to benefit deprived areas. As of June 2008, around 100 CICs had been established in selected communities. The communities were selected subject to them already having access to certain facilities such as electricity and telephones. The CICs are at various stages of development. According to a survey and evaluation mission conducted by the UNDP office in Accra in June, 2008, the CICs are at various operational and functional levels.

The Community Information Centre with full operational capacity is a centre that is fully equipped, not just with computers but with staff members who have the requisite ICT skills and managerial know-how to be able to handle the equipment and to manage the Centre with all the competence it deserves. A fully operational and functional level CIC must therefore have the following: the physical building itself with electricity and telephone facilities; a Local Area Network (LAN) with at least five (5) workstations or computers; one server; one switch; one printer; one scanner and five (5) UPSs (Uninterruptible Power Source).

These CICs will provide a wide range of services to the communities they serve, which will further lead us to probe who the targeted beneficiaries of CICs are in a typical deprived community. A CIC's basic responsibility is not just to provide Internet cyber café services to the community, which is so far the focus of most CICs that were visited in April 2008. Rather, the CICs have been mandated to provide ICT training opportunities in the area of basic computer literacy to people living in these communities. Furthermore, the CICs are to support business activities in rural communities by providing marketing information on improved agricultural production and extension services. More importantly, the CICs are strategically positioned to disseminate and educate rural folks on government policies, programmes and projects, especially in the areas of health, education, agriculture, environment, local government by-laws, tourism potentials and investment opportunities in their own localities and how they can tap those using ICT tools.

The main beneficiaries of CICs, among many others, are members of the community at large, schoolchildren, school-leavers, women and women's groups, private business entities, non-governmental organisations (NGOs), local government authorities and, of course, our most traditional authorities.

Wiring Ghana Initiative

The government of Ghana has initiated the construction of a new underground fibre-optic backbone, under the project name "Wiring Ghana", which Huawei, the Chinese IT giant, will undertake. This network will be 4,000 km long and will ride along the electrical transmission system. The Southern half has been completed with a $30 million loan facility by the government of China. Another $70 million will be made available to complete the Northern sector of this project. It is expected to be completed by the end of 2009.

GT Broadband4u

Ghana Telecom has broadband facilities (Broadband4u) in all ten regions of Ghana and recently launched an initiative to send it to most of the cities and towns in each region. This is expected to help connectivity in the rural areas.

Pay-As-You-Go

Pay-As-You-Go (PAYG) is a solution developed by HookMeUp (HMU) Technologies that uses VSAT or other forms of telecommunications transport media to deliver high-speed Internet to the last-mile (home, office, estate, etc). This is a private initiative. Pay-As-You-Go resolves the problems associated with cost of access, because it is retailed in low denominations with the lowest set to 30 minutes access time (about 30 peswas). Because it is Pay-As-You-Go, a monthly subscription fee does not apply; a user or a

location will only buy access when they have exhausted the pins from their last purchase. Each user has equal and dedicated access to the bandwidth available for the duration of their session, which is valid for a set duration, and a data limit applies within the validity period.

With Pay-As-You-Go, you can buy a batch of vouchers, which may last you for the entire year or can be retailed to other users of the Internet in your community. The set-up cost ranges from $50 USD to $2,500 USD, depending on user location and distance from a Pay-As-You-Go hotspot.

Services have been deployed in Accra, Tamale, Bimbilla, Yendi and partnered with IICD to implement this solution at the SALAGA Community Information Centre (CIC). This CIC has a hotspot which provides the community with access to Wi-Fi.

The challenge with this solution, however, is the problem of remembering the user ID and passwords, but HMU Technologies say they will solve this problem by the end of the first quarter of 2009.

GIFTEL

GIFTEL (Ghana Investment Fund for Telecommunications) has other initiatives to send connectivity to rural areas. From the 1 percent contribution from the telecommunications operators, telecom infrastructure is built in many rural areas and is shared by these operators for connectivity in these areas.

Applications and Uses of Connectivity

There are so many uses of connectivity in Ghana. One of the most common and critical uses of connectivity, which everyone is aware of, is sending emails. But this is not the only use of connectivity in Ghana. Some of the many other uses are listed below.

Options

Surfing the World Wide Web

This is the most conventional type of access. In Ghana most people who surf the Internet use it to search for information and news, both local and international. Most people use Google for their research and surf local news sites such as www.myjoyonline.com and www.ghanaweb.com and international ones such as www.bbc.co.uk and www.cnn.com.

Video-conferencing and Chat

In recent times, video conferencing has started to become popular in Ghana. Most businesses are using it to contact their business partners elsewhere for effective communication. Because of bandwidth constraints, it is not moving as fast as it could. Internet chatting is also very popular in Ghana with Skype and yahoo messenger. These days, people even call themselves on these two services.

Voice-Over Internet Protocol (VoIP)

Ghana Telecom and Westel have licenses to operate Voice over IP. Under the laws governing the operation of voice service in Ghana, the two fixed telephony operators, Ghana Telecom and Westel, had exclusivity over the country's international voice communication gateway. This means that all incoming and outgoing international calls must be routed through their networks.

The exclusivity enjoyed by the two fixed operators ended in 2002. Despite mounting pressure from data communication operators, it remains to be seen when this law will be reviewed. However, the Minister of Finance and Economic Planning, Mr Kwadwo Baah Wiredu, assured operators in the 2007 Budget that the Ministry of Communications in consultation with the NCA would ensure clarity/regulations on the rules of engagement for Voice over Internet Protocol (VoIP). The NCA has only verbally said that VoIP is legal as a technology, however, the regulation to lay out the framework is yet to be promulgated.

E-Mail Communication

This remains the oldest and most critical use of connectivity. If a link is needed for e-mail only, the cost of service can also be drastically lower than a full-service link.

Main Types of Connectivity Available

Overview

In total, there are 114 licensed Internet Service Providers (ISPs) in Ghana, twenty-seven of which are actually operational. Internet access in Ghana is mainly achieved through the usage of Internet Cafés. These are estimated to number more than 2,000, with 90% of them concentrated in the urban centres, mainly Accra and Kumasi. This is still a very fragmented market which is primarily made up of small cafés with the capacity to seat 5 to 15 individuals, with the exception of larger cafés such as BusyInternet, which boasts over 100 stations and a 24/7 operational capability, and serves over 1,500 visitors daily. The majority of the other Internet Cafés have, on average, 10-15 seats. The average national charge is about US$0.08/minute.

Companies provide ISDN (Integrated Services Digital Network), HDSL (High-speed Digital Subscriber Line) or ADSL (Asymmetric Digital Subscriber Line) to their corporate customers, but for most private end-users dial-up services have been available and, recently, broadband services. InternetGhana was the first company to introduce ADSL. Presently, companies such as Africa Online Ghana Limited, Engineering Systems and Services, Zipnet, BusyInternet and Ghana Telecom (GT), among others, are providing the same services. Asymmetric Digital Subscriber Line (ADSL) is the main broadband technology (apart from wireless) with Ghana Telecom (GT) as the leading provider. Ghana Telecom's broadband service, Broadband4U, was launched in 2004 and was limited to 10 telephone exchanges in Accra. By early 2007, it had coverage in almost all the regional capitals. The use of wireless (WiMax) is also gaining credence, again with InternetGhana as a pioneer. Companies such as KNET, IDN, NCS, Ecoband, Africanus, iBurstGhana, AccelonGhana, etc. are also providing wireless broadband services in the country. There were about 14,000 broadband subscribers in Ghana as of December 2007.

Types of Connectivity or Technologies in Ghana

Wired

Copper

Copper is not a competitive means of carrying data/voice in Ghana, given the more competitive technologies available. To date, Ghana suffers from a very poor copper network with chronic theft issues which make it all the more difficult to maintain and repair. It is estimated that up to half of the ADLS circuits are not functioning on any given day. The outlook for copper, given the commodity's current high prices, theft of wires and high associated expense for deploying it, as well as its limited usage makes the outlook for its expansion seem rather bleak. There are no known efforts for new investments in copper-based networks. Current Base: 0.35MM. There is no growth forecasted in copper *per se*, as it is expected to be overtaken by WiMax and Wireless Local Loop lines.

Mobile technologies

CDMA derived: CDMA 450 WLL, CDMA 2000 1xRTT, CDMA 1xEVDO

The following companies use CDMA-based technologies: Kasapa provides mobile phone services through ZTE deployment of CDMA2000 technology. Netafrique and TeleData ICT have both signed agreements with Kasapa to use this technology for the deployment of mobile wireless solution in areas where there is Kasapa coverage. This technology has limited adoption, mainly because it is not well suited toward large-scale IP-based traffic. Actual Subscribers: 0.2MM. Projected Growth 2012: 0.4MM.

GSM derived: Edge W-CDMA or UMTS, GPRS, HSDPA

MTN (formerly Areeba)/ GT's OneTouch/ Tigo (formerly Millicom) use these GSM derivatives. They can be used for services such as Wireless Application Protocol (WAP) access, Short Messaging Service (SMS), Multimedia Messaging Service (MMS), and for Internet communication services such as email and World Wide Web access. GPRS data transfer, for example is typically charged per megabyte of traffic transferred, while data communication via traditional circuit switching is billed per minute of connection time, independent of whether the user actually is using the capacity or is in an idle state. There is a very strong outlook for these technologies, especially in the areas of HSDPA. Actual Subscribers: 5 MM. Projected growth 2012: 12MM.

Mobile Internet Modems

MTN, Tigo and Onetouch have GPRS modems which allow you to browse and use the Internet on your laptop or PC using GPRS modems and special Data SIM cards. Kasapa also sells CDMA modems through

NetAfrique and Teledata ICT. What this means is that wherever there is coverage of these networks, it is possible to browse the Internet. These GPRS and CDMA modems cost about $250, and about $2 and $2.2 per hour then has to be paid to access the Internet.

Wireless

Wimax
Deployed mainly by the leading ISPs, (Internet Ghana) and Ghana Telecom as well. Many have high hopes that it will provide a solution for the areas where fixed-lines have failed, due to its maturing technology and ease of deployment. NCS was first ISP to deploy it during the last quarter of 2006. Mainly in Accra, Tema and Kumasi regions with plans to expand into more rural areas. If this technology is applied towards the Wireless Local Loop principle, we could see a growth of between 1.5MM to 3MM in 2012.

WiFi
WiFi is mainly deployed in the rural parts of Ghana where there are no copper lines. It is mainly deployed by private service providers and organisations interested in rural connectivity. Wireless Ghana and Arrow Networks are two of the few organisations that deploy WiFi in Ghana and could see strong growth in this technology. The 802.11 standard is an unlicensed frequency band and can be used by individuals and organisations. All organisations that seek to commercialise WiFi in Ghana are licensed by the NCA to provide these services.

The following table lists the current mobile technologies and their operators.

Technology	Operators
GPRS and EDGE	• Areeba • Tigo • Onetouch
CDMA2000 1x	• Kasapa
iBurst	• Infinite Stream • BusyInternet • Africa Online
WiMAX	• InternetGhana

iBurst
SA's iBurst operates in conjunction with BusyInternet. To date, there has been very limited adoption due to massive management challenges as well as what is perceived to be a flawed pricing model by the market (bandwidth-based rather than time-based). Although the technology makes sense, it is still a costly alternative, and its marketing to date has won very few converts. The outlook is currently bleak for this technology. It has had an insignificant impact on the industry since its inception.

Satelites (VSAT)
VSAT will continue to have its place, particularly in underserved places, and where uptime links is critical (International Corporations such as mining conglomerates, and agribusiness companies, use them). There are currently 57 licensed companies employing VSATs and they provide both C-band and Ku-band. It is also being used as a back-up to connectivity through SAT3. Major players are Ecoband and GS Telecom.

With VSATs, two main frequency types exist, the Ku and the C band. Satellite systems that use C-band employ large antennae which give a very high quality signal. They are mostly used by large corporations such as oil and mining companies and are also used in telemedicine. The Ku-band has shorter wavelengths and so smaller antennae are used to receive signals. The Ku-band has come into widespread use more recently. The quality of signal is lower, but this is acceptable for most domestic and small business uses. Most broadcasting stations use Ku-band, as do Internet connections from servers to users with terrestrial return links. Cost wise, C-band VSATs are more expensive than Ku-bands.

Fibre optic

SAT3, an undersea fibre optic cable, is underused and mismanaged from a business development standpoint. Although many in the sub-region will say that Ghana's usage of SAT3 is exemplary, it has been recently overtaken by Senegal's Incumbent Telco. Indeed, the prices are still too high to justify purchasing circuits. Also, the lack of any SLAs (Service Level Agreements) prevents the customers from ensuring they are getting their money's worth. Ghana Telecom (GT) has just been privatised and still enjoys what seems to be a monopoly situation with respect to the SAT3. There were talks of spinning off the SAT3 landing and management into a separate entity, but that did not happen.

GISPA, Ghana's ISP association, has been very successful at lobbying GT to lower its prices. SAT3 remains a very under-utilised resource which is not benefiting the people of Ghana, which it was initially designed for.

The national backbone is currently an area of much activity. There is an existing backbone, which rests above ground, riding the electrical network of the Volta River Authority. Currently, the network has three users: Ghana Telecom, Volta River and TV3. Guiness Ltd. also uses it to connect its Kumasi office to its Accra office. Indeed, there is a fibre-optic cable located atop each electrical pylon of Voltacom which covers the nation. This network is 800 km long.

There is recognition at the government level for a much-needed, better under-ground fibre optic backbone to allow economic growth. Hence, there is a new government-owned initiative to build a new underground fibre-optic background, called "Wiring Ghana", which Huawei, the Chinese IT giant, was undertaking but stopped due to lack of funds. The first phase has been completed and included in the sale of Ghana Telecom to Vodafone. This network will be 4,000 km long and will ride along the electrical transmission system. There are also some private efforts that are working on laying down their own fibre-optic backbones over the next couple of years.

Difficulties associated with connectivity in Ghana

The wide use of the copper lines belonging to Ghana Telecom (GT) presents a lot of difficulties associated with connectivity in Ghana. Ghana suffers from a very poor copper network with chronic theft issues which make it all the more difficult to maintain/ repair. It is estimated that up to half of the ADLS circuits are not functioning on any given day. This affects mainly customers of the GT Broadband4U services. This service lacks appropriate technical expertise to make it run efficiently. An interview with one customer of Broadband4U shows an estimated downtime of about 30 minutes a day. Sometimes, customers experience a whole day of downtime, due mainly to a lack of technical expertise.

Satellite and wireless connectivity in Ghana are fairly reliable and present good ways to connect to the Internet. Dial-up Internet also presents the same challenges presented by Broadband4U services, mainly due to the fact that they also use these same copper lines.

Narrowband is widely used in Ghana and, although it has advantages in respect of speed of deployment, its disadvantage is that the connection speed will not exceed 64kbps for each site. This is due to the high cost of deploying these networks. This means that communication within networks works well, but the Internet access speed is limited and there is very little bandwidth left for a voice network, while video is completely left out.

Streaming is entirely disabled on certain networks, but where it is present it tends to strain the network. Most organisations try to limit access to streaming by staff as a result of the strain on the network and, because true broadband in Ghana is relatively expensive, it makes sense for these organisations to limit streaming. Those organisations that can afford broadband, however, do enjoy these services.

Technical Considerations on Connectivity

Bandwidth Allocation – shared vs. dedicated

When an Internet Service Provider (ISP) sells a service based on bandwidth, it usually gives two options. The first is shared. This implies that, as a customer, you are 'sharing' that bandwidth with other users. So, a 128kbps shared link theoretically means that there are several users sharing the same 128kbps link. Some customers then demand to know the ratio according to which this bandwidth is shared and an Internet Service Provider can rarely give a definitive answer to this question, although they may offer a range of different answers. The reason is that, in practical terms, it is not feasible to break down a larger pool of bandwidth into little segments that can be shared. For example, if an ISP has 10 customers who are buying 128kbps shared, but their 'over-sell' ration is 5:1, then it is not practical for the ISP to have a 512kbps pool broken down to 2,128kbps pools and put 5 customers in each pool.

Instead, they put all 10 customers in a pool of 512kbps. They then limit the maximum bandwidth per customer to 128kbps. Therefore, in the best case scenario you will get 128kbps if there are only two active users and only 51.2kbps if all ten customers were pulling as much bandwidth as possible; a situation that is quite rare. To add to the above intricacies of Bandwidth Sharing, an ISP may have a general over-sell ration but very few have dynamic bandwidth control mechanisms that auto-regulate the size of the overall pool. Most ISPs, if they do any form of bandwidth control at all, do it manually through rules and policies.

Dedicated Bandwidth on the other hand is as simple as it sounds. A customer is sold a segment that is fixed and will not be used by anyone else, even if is not used by the customer. Bandwidth is expensive, so this option has a substantially higher cost for the end-user.

Service Monitoring Tools

Users usually get embroiled in arguments and disagreements with the ISP when they are not receiving good service. There are usually two main reasons for this: either the customer is genuinely getting a bad service but cannot prove it, or the ISP is actually delivering the right service but the customer is using it inefficiently or it is being wasted without the customer knowing how. In such circumstances it is useful to ask the ISP for access to the user's interactive Multi Router Traffic Grapher (MRTG) graph. This is a very common tool that monitors and graphs the customer's bandwidth usage and this will provide a qualitative measurement that could help in the discussions and resolve any problems. Alternatively, there are many tools available to monitor the total bandwidth, transfer rate, and even determine the type of use of the service that the customer is receiving. This helps to determine the Quality of Service delivered, the up-time calculation, and helps the customer detect any leakage or abuse of bandwidth such as viruses and worms on the network, or excessive downloads like movies and songs during office hours and so forth. Likewise, there are simple devices that can help an organisation or company to monitor and actually control the type of uses on the network. For example, a simple bandwidth control hardware (or software) can easily allow certain users to access e-mail only and others to access the web, while blocking other services like P2P (often used to download songs and movies) or chatting. It can even regulate these policies according to the time of day – such as chatting allowed only after 5:30 pm. These types of control mechanisms are highly advisable for users as they will ensure that this expensive resource is used and maintained as efficiently as possible.

Some Useful Sites and Tools for Better Network Management

In general, network monitoring is a specialised task. It is usually recommended to hire a professional to adequately monitor your traffic and send you an analysis. Although this is an additional cost, you may find that ensuring that your bandwidth is monitored and controlled well in this way could save you more money than it actually costs to hire such a professional vendor.

However, there are many simple sites and tools available that you could use even if you are not very technically savvy. A simple search on Google will reveal hundreds, but here are a few that could be very useful:

To test your download speed

You can use this free tool to test your maximum bandwidth speed at the time of doing the test. If you are on a network, it is useful to do this test with only one virus-free PC connected. This way, you can find out what speed limits your ISP has in place. Go to:
http://www.bandwidthplace.com/speedtest/

Download Utility

This utility helps you download files even if your connection is slow or intermittent. If, during a download, the connection is lost, the download will pause and resume automatically when connection is restored. There are many such utilities, and this is one of them:
http://www.tensons.com/products/downloadacceleratormanager/freeedition

To monitor your 'up-time'

You can use a 'ping' program that simply records when a certain site is accessible. You can use this to test certain equipment in your network (such as your network printer), and equipment at your ISP (such as your gateway) as well as to monitor an international site to determine if you have connectivity. Therefore, if you cannot get onto the Internet, you may find that the link to the ISP is fine, but that the problem lies in the onward route.

Up-time monitoring tools

1. IPCheck Server Monitor by PAESSLER. A free version allows you to monitor up to five IP addresses at intervals of 15 minutes. The commercial version allows you to monitor more IP addresses at more frequent intervals. See: http://www.paessler.com/ipcheck

2. FREEping by tools4ever. Similar to the above. See
http://www.tools4ever.com/products/free/freeping/

3. Graph-a-ping by Mata Luis. Similar to above with a nice graph. See:
http://www.mataluis.com/index.php?option=com_content&task=view&id=37&Itemid=36

4. Visual Ping by IT Lights Software. Similar to above. See:
http://www.mataluis.com/index.php?option=com_content&task=view&id=37&Itemid=36

Monitor your bandwidth use

This becomes a little tricky because the PC you use to load the monitoring software should either be:

1. in-between the external network and the internal network – this means that the PC used to monitor should be the 'gateway' or 'firewall' of your network. All traffic between your ISP and your internal network must pass through this PC; or
2. be able to monitor a network interface that is SNMP-enabled. This means that the port that is being monitored should be able to relay needed data to your application. This is usually possible in mid-range and higher range routers and firewalls such as Cisco, Multi-Tech and so forth.

Useful Software

1. PRTG Traffic Grapher by PAESSLER. This is similar to MRTG but can run on a Windows PC and is a little easier to set up for people with little technical experience. There is a free version that is limited but helpful and a more commercial version. See: http://www.paessler.com/prtg

2. BMExtreme by LP23.com. This is simple and cheap software ($25 for home use and $50 for professional use) that can monitor bandwidth. See: http://www.lp23.com/bmextreme/

3. MING Bandwidth Monitor by MING Software. This is an affordable ($15 with a 14-day free trial) software that allows you to monitor overall traffic as well as traffic from each connected PC. In this way, it is also useful for finding the PCs with unusually high traffic, such as those misusing the service or those that may be infected with a virus. See http://bandwidth.mingsoft.com/

4. Bandwidth Meter Pro. This is $20 software that shows you impressive graphs of bandwidth usage. See: http://www.bandwidth-meter.net/index.htm

Tools to control bandwidth use in your network

Apart from the above tools that merely 'monitor' bandwidth usage, there are others that allow you to control bandwidth usage within your network. With these tools you should be able to allocate bandwidth to each user as per their requirement, allocate certain priority allocations for 'mission-critical' applications such as video-conferencing, as well as limit or regulate types of usage, such as music downloading, chatting and so forth. All of these tools will only work if installed on the gateway computer. Here are a few:

1) Routix NetCom. This is a free software. See: http://www.routix.net/netcom/

2) SoftPerfect Bandwidth Manager. This is a user-friendly utility. It costs $35 or $100 depending on enabled features. See: http://www.softperfect.com/products/bandwidth/

3) JDSoft Bandwidth Manager. This software costs about $60 for a home edition version and $230 for enterprise edition, although the home edition should suffice for most small networks. See: http://www.easyfp.com/bandwidth-manager/index.html

4) Traffic Shaper XP is a free utility for Windows OS. See: http://bandwidthcontroller.com/trafficShaperXp.html

SLA (Service Level Agreement)

This is an agreement that outlines issues relating to the quality of service that will be delivered by the ISP, as well as its reliability and other factors. It may also contain a clause about a refund formula in the event of the ISP failing to meet the minimum acceptable terms of the SLA. This SLA is also highly advisable for customers. However, many ISPs only offer this option to customers who pay for higher levels of service as this is a liability for the ISP. If you are able to get an SLA, there are a few fundamental issues that are particularly important, such as:

Up-time guarantee

This is a percentage of the time they guarantee the service provided. For example, an ISP could guarantee an uptime of 99.5%. This means that in a month of 30 days they guarantee that down-time, if any, would not exceed 3 hours and 36 minutes. Be careful to notice the definition of 'up-time'. In other words, up-time to where? Up-time to ISP? Or up-time to the global Internet?

Compensation for down-time

This is a formula with which the ISP will be penalised for not meeting the minimum up-time guarantee. This is the penalty for the amount of down-time beyond the stated minimum. For example, if the up-time is guaranteed at 99.5% or 3 hours and 36 minutes, then anything above that must be compensated for.

Latency

This is the time it takes for a small amount of data (usually 32bits) to travel a complete round trip. This has been discussed previously, but a normal satellite connection would give about 600 milli-seconds latency at best. This is very easily tested by running a 'ping test'. A ping test is a utility that is available on all computers and it tests the amount of time (in milli-seconds) that it would take for a 'packet' of data to be sent and a response to be received. Be careful that the SLA does not have a hidden clause of offering a one-way reading. It must include the complete reading of both send and receive time.

Geographic coverage

Ghana Telecom's infrastructure does not cover most parts of Ghana – especially most peri-urban and rural areas. The company has therefore introduced a new product called the Fixed Cellular Terminal (FCT). This FCT emulates the services provided by fixed line telephones using GSM networks. It is a solution for providing access to fixed services where there are no traditional fixed network infrastructures or additional fixed phone lines are needed. FCTs are installed in areas, communities, and towns where Ghana Telecom has its GSM coverage and operate on the GSM triple band (GSM900 MHz/GSM1800 MHz/GSM1900 MHz). FCTs have all the features that the Onetouch GSM network has, including Internet access via the GPRS technology that was launched on the Onetouch network in November 2006.

Because Ghana Telecom is an infrastructure provider with a vast infrastructure in the regions, most ISPs use its infrastructure for connectivity to other regions. Even so, Ghana Telecom's infrastructural assets are only limited to the regional capitals and some towns. For Ghana Telecom or the other ISPs to reach the rural areas, the most feasible option they use is Wireless technology. The Wireless Ghana initiative at Apirede in the Eastern region of Ghana is mainly involved in sending connectivity to the rural areas. Arrows Networks is a private firm which is also involved in building wireless networks. It has extensive network covering Accra, Winneba, Cape Coast, Takoradi and the surrounding areas. It also embarks on some rural initiatives but is mainly involved in commercial ventures.

In order to increase connectivity in the rural areas, the government charges all operators one percent of their revenues for a rural telecommunications fund called the Ghana Investment Fund for Telecommunication (GIFTEL), which has been in operation since 2005.

Table 2: Regional distribution of Ghana Telecom (GT) subscribers (December 2002)

Regional distribution of Ghana Telecom subscribers (December 2002)				
	Subscribers		Teledensity	% of country's population
	Number:	% of total:		
Greater Accra	184,526	67.7	6.0	15.4
Ashanti	27,947	10.3	0.7	19.1
Western	17,009	6.2	0.8	10.2
Eastern	10,057	3.7	0.5	11.1
Central	8,621	3.2	0.5	8.4
Northern	5,438	2.0	0.3	9.6
Brong Ahafo	6,808	2.5	0.4	9.6
Volta	6,311	2.3	0.4	8.6
Upper West	1,728	0.6	0.3	3.0
Upper East	4,084	1.5	0.4	4.0

Source: *Fostering and facilitating Access on SAT-3/WASC/SAFE* by Spintract

From the table above, the Ashanti region accounted for about 19% of Ghana's population but with only about 10.3% of GT fixed line subscribers in 2002, and Accra accounted for about 67.7% of GT fixed line subscribers.

The mobile networks have covered a wide range of Ghana's geography. It is now possible for people living in the villages to own mobile phones, the only challenge being electricity to charge the phones. Mobiles are therefore key contributors to bridging the urban-rural digital divide in Ghana. Kasapa deploys mobile services using the CDMA2000 1x technology. MTN, the main mobile operator in Ghana with about half the mobile subscriber base, uses a combination of the GSM900, GPRS, and the EDGE technologies. TiGO and GT Onetouch also deploy these same technologies; however, the MTN network has a much wider geographic coverage.

Rural energy

Options for rural energy in Ghana

One of the major challenges to rural connectivity in Ghana is the availability and access to reliable power options in Ghana. Although 57% of households in Ghana have access to mains electricity, the generation capacity is inadequate, resulting in scheduled load shedding (often for 12 hours at a time) and many unplanned power cuts. The economy of Ghana is thriving, and the lack of electric power is a growing concern. Electricity shortages are discussed daily in the newspapers. The problems have arisen largely due to the lack of water in Lake Volta for the main hydroelectric power station, and the high price of oil limiting thermal generation, coupled with increasing demand. The average annual electricity consumption per capita is 285 kWh, compared to a global average of 2,490 kWh, and has fallen from 450kWh per capita in 1980.

Of the 43% of the population without electricity, most live in the rural areas, several kilometres from the capital, Accra. Here, the main source of income comes from seasonal agriculture, and many people are cautious about connecting to the mains if the grid arrives, for fear that they will run up a bill that they cannot afford to pay.

This section looks at various power sources in Ghana that are used for rural connectivity.

Power grid

The power grid comprises several power options which the Volta River Authority owns to generate electricity for the country. It comprises mainly hydro power options and thermal power options. The total installed generation capacity is 1,778 MW. This comprises:

- The Akosombo Hydroelectric Power Plant with an installed capacity of 1,038 MW. The Akosombo plant has been retrofitted with the replacement of the old turbine runners with new ones as well as electromechanical works aimed at restoring the plant to its original condition. The retrofit was completed in March.
- 160-MW Kpong Hydroelectric Power Plant
- 550-MW installed thermal capacity at the Takoradi Thermal Power Station and;
- 30-MW Diesel Power Plant at Tema.

A 125-MW Power Barge “the Osagyefo Power Barge” is also available and is currently berthed at Effasu Mangyea in the Western Region with arrangements ongoing to establish viable fuel sources for it. The Osagyefo barge was developed by the Ghana National Petroleum Corporation in order to utilise the natural gas available in the Tano oil and gas fields for power generation. The barge has been completed and is yet to go into commercial operation.

The table overleaf shows the available power options on Ghana’s power grid.

Generation Source	Effective Capacity (MW)	Percent of Total Available Effective Capacity	Installed Capacity (MW)	percent of Installed Capacity
Hydro:				
Akosombo	850		1020	
Kpong	120		160	
Total Hydro	970	56	1180	55
Thermal:				
TAPCO	320		330	
TICO	220		220	
TDS	15		35	
OECF Barge	0		125	
Total Thermal	555	32	710	33
Imports	200	12	250	12
Total Installed Capacity Including Imports			2140	100
Total Available Effective Capacity	1725	100		81
System Coincident Peak Demand*	1200	70		56
Reserve Margin	525	30		25

*VRA System Peak Without VALCO @ 3 Pot-Lines

TAPCO - Takoradi Power Company
TICO - Takoradi International Company
TDS - Tema Diesel Station

Sources: *Guide to Electric Power in Ghana*, 1st Edition, University of Ghana, Legon, 2005. 2: VRA 2005.

Generator

Generators are widely used in Ghana, but mainly as a back-up system when the national power grid fails. In 2007, when the country suffered from a power crisis, this was the main source of power for companies and certain individuals who could afford it. The generator is a rather expensive source of power for rural areas because fuel for these generators and their maintenance can be rather expensive.

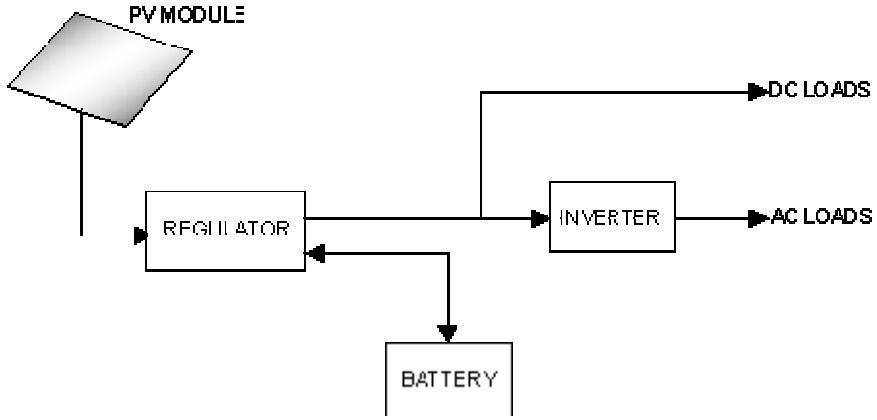
Solar

Ghana is ideally placed to make use of solar PV, especially in the rural areas, but there is a need to rapidly increase the number of people trained in installing and maintaining them, and to develop the business opportunities that are currently present.

Photovoltaic (PV) modules generate electricity from sunlight. Used with re-chargeable batteries to store electricity, they can provide an independent DC (Direct Current) electricity supply system that can be used both day and night. A PV system incorporates a charge controller, which prevents the battery from being over-charged or deep-discharged, and may also include an inverter to convert DC (Direct Current) power to AC (Alternating Current), thus allowing the use of AC (Alternating Current) appliances.

Deng Ltd is a solar supplier that sells and installs several different types of PV system in rural communities in Ghana. A main part of their PV business is the supply of standalone systems. The smallest solar-home-system uses a 14 Wp module, a 40 Ah battery and 6 A charge controller, but larger systems of up to 100 Wp and 100 Ah are also popular. Systems up to 500 Wp in size are used for clinics and other community buildings. The systems sold by Deng use either amorphous or crystalline solar PV modules. Modules and charge controllers are imported from Europe, while batteries, wiring and support structures are all available locally. Customers can choose between deep-cycle solar batteries or car batteries; because a charge controller is always used, the car batteries last for a reasonable time – about two years. Some customers start with a car battery to minimise the initial system cost, and upgrade to a more durable deep-cycle solar battery when the first car battery needs replacement.

Amorphous silicon PV modules are used, because for small power demand they are cheaper than crystalline modules. Amorphous silicon has a poor reputation in some parts of the world because, in the past, modules degraded rapidly in use, usually because poor sealing of the edges led to water absorption in the thin layer of silicon. The following figure shows how the solar system works;



Hydro power

Some rural communities have been connected to the national power grid which mainly runs on hydro power.

Wind power

Wind power is when the movement of wind is converted into electricity using a 'turbine'. Wind power is less commonly used in Ghana than solar power. However, it is generally cheaper and preferable for areas that have a steady and constant breeze.

Wind turbines usually have two to three blades which spin in the wind. The blades are connected to a rotor which drives an electricity generator. It works on the same principle as a dynamo on a bicycle, but on a slightly bigger scale. The blades and rotor are mounted on a movable axis which has a fin connected to it as well. The purpose of this fin is to always direct the rotor and blades directly into the oncoming wind.

Wind turbines come in a large variety of sizes ranging from very small units, usually used on yachts and small ships, to massive 'wind farms' that produce enough power to supply a small city. The biggest known wind turbine is the Enercon E112 which has a rotor diameter of 112 metres and an output capacity of 6MW. (Source: Wikipedia)

A smaller wind power system has many of the same components as a solar system, except the wind turbine replaces the solar panels. It generates and stores power in very much the same way, compensating for periods during which there is little or no wind with periods of high wind. Wind systems are generally cheaper than solar systems but this is only true on the international market. After importation, they seem highly priced. This may be due to shipping costs, the lack of sufficient competition in the market, or as a result of low demand for the product.

Although they are slightly cheaper then solar power (on the international market, that is), they need a little more maintenance than a solar system. This is because the turbine is constantly turning and, every once in a while, it is advisable to make sure that all the moving parts are well lubricated. This can be a daunting task when the rotor is mounted 3040 metres off the ground! Installation is also slightly more difficult because the rotor must be mounted on a mast or tower in order to stay clear of wind turbulence. Wind turbulence occurs closer to the ground and forms uneven and bumpy wind patterns that are not good for either the rotor or the turbine. They are like 'pot-holes in the road'.

Energy use of equipment

This section is to help calculate energy consumption of the appliances used and the number of hours that the appliances will be used per day. Each appliance should be rated either with Watts or with the Maximum Current Load. You should also know the voltage; it is usually 220V. The watts are calculated as the Amps X Voltage. Therefore, if you have a PC that is rated at 1.2 Amp Maximum Current operating from normal supply power (220 V), then the Wattage is 220 V X 1.2 Amps = 264 Watts. However, it is highly unlikely that it will operate in this 'maximum current' state all the time. Therefore, it may be alright to assume 60%-70% of the maximum current as the regular operating current. This gives approximately 160 watts of power per computer.

An indication of the approximate energy needs of a few common appliances are as follows:

Type of ICT equipment	Power Requirements
Laptop	75 Watts
Desktop PC	300 Watts
15" Monitor (Flat screen)	65 Watts
15" Monitor (old style)	500 Watts
Light bulb (standard – 40 W)	40 Watts
Light bulb (energy-saving – 20 W)	20 Watts
Laser Printer, small	550 Watts
Ink-jet Printer, small	100 Watts
Wireless router	50 Watts
V-SAT satellite Receiver	500 – 1,000 Watts

Source*: Guide to Electric Power in Ghana.* 1st Edition, University of Ghana, Legon, 2005. 2: VRA 2005.

Now determine how many computers will be connected and how many hours per day they will be used. Let us assume there are 10 computers and the centre is open 8 hours a day. Based on experience, it is possible to judge how many hours, on average, each computer will be used. For example, each computer is used on average for 4 hours a day. This gives a load of 160 watts X 10 computers X 4 hours = 6,400 watt hours per day. Other appliances must be included in the calculation too. To simplify, you can use a table like the one below:

Load Calculation Worksheet

Appliance	Qty (1)	Watts (2) (Amps X Volts)	Hrs/Day (3) Of usage	Watt Hrs per day (= 1 X 2 X 3)
Computers	10	160	4	6,400
Lights	2	40	10	800
Total Watt Hours Per Day (4):				7,200
Total Watt Hours Per Month (4 X 30 days):				216,000
Total Kilowatt Hours per Month (above divided by 1000):				216

Sources*: Guide to Electric Power in Ghana.* 1st Edition, University of Ghana, Legon, 2005.

Challenges with rural energy

The biggest challenge with rural energy is the cost of sending energy to rural communities throughout the country. It is extremely expensive for the government to deploy energy through the national grid to these parts of the country. Apart from the cost, the transportation to these areas is a major problem as well. The roads connecting these areas are highly unmotorable. Moreover, the cost of power in general is increasing and the rural folks would rather stay in the dark than pay huge electricity bills.

The cost of solar energy in general has gone down from where it was many years ago, and feels like it has reached a point where it is comparatively affordable (or maybe the fuel prices have gone up). But It is important to note that acquisition, maintenance, and installation of solar equipment in West Africa is

several times more expensive (on the order of 10x) than it would be in China or India, often due to the cost of customs, transport, and shipping, but also due to the difference in the cost of labour, and the availability of raw materials such as steel, as well as the unavailability of galvanised steel.

In Northern Ghana they have a Winter dust season, in which everything gets covered over with a layer of dust all-the-time, which also interferes with the efficiency of solar power, and thus requires constant maintenance (i.e. dusting and washing the panels). It is recommended that people work on wind power, or a combination of solar and wind power, which seems like it might be more suitable for the environment. Ghana also has a coastline and may, therefore, even be able to leverage coastal wind generators for additional power.

Power back-up and protection

Protection from instant power failures is very important. This is usually solved by having an online UPS (Uninterruptible Power Source). This device is fed from the main power source. It has an internal (or external) battery that is charged continuously. When the power goes off or becomes unstable, the UPS takes over and supplies power from the battery. The back-up time that a UPS provides depends on the capacity of the UPS and the energy use of equipment that is connected. For example, a 1KVA UPS supplying 2 PCs with flat screens may give 90 minutes of extra power but, if regular monitors are used, it may only provide an extra 45 minutes of power.

The UPS also provides protection because it controls power fluctuations. It also prevents high voltage 'spikes' as it will usually burn out before the PC does. This is not the best way to protect your PC as each time there is a big spike you blow up a costly UPS! It is therefore advisable to place a 'surge arrestor' which costs around $10 to $20 in between the UPS and the mains supply.

A short run power back-up system consists of small UPSs that can give up to 30 minutes of power: enough time for you to save the work you were doing and safely shut down the computer.

An extended system is one that is designed to allow you to work for an extended period of time, usually above 2 hours. An extended power back-up solution can give you anything between 2 hours and 24 hours (or more!) of extra power. These devices are more expensive and usually have external batteries. They are good for 'mission-critical' servers and PCs that should work regardless of the power situation. When you select such a system, be sure to get an 'on-line' UPS. The grid power comes in 'alternating current' or AC. This means that the voltage alternates between the conductors 60 times per second. Contrary to that, 'direct current' or DC, e.g. from a battery, is a constant flow at all times. So when a UPS is charging a battery, it converts AC to DC current and, likewise, when a battery is powering your PC it is again transforming DC to AC current. To do this efficiently it must 'simulate' AC current. The quality of the UPS is determined by how well it can simulate this alternating current. A pure AC is graphically represented by a pure sine wave. On a graph, this looks like a smooth and consistent wave. A simulated AC is usually 'stepped' and on a graph looks like a jagged line, resembling stairs. If the 'steps' are relatively small, they are not felt by the PC and it is therefore safe. If the steps are too large, the PC detects it and may burn out as a result.

Inverters are not to be confused with Extended UPSs. Although they perform exactly the same function, inverters give an output that is not a smooth sine-wave. It is sometimes considered to be 'dirty power'. While this is suitable for most applications, it is detrimental for sensitive electronic equipment such as computers.

The quality of an extended UPS is also determined by its efficiency. Converting AC power to DC power and vice-versa is a costly business since each conversion brings along power losses. For example, converting from AC to DC for charging may be only 60% efficient and the same for converting the other way. This means that you need 100 units of power to give 60 units (60% of 100 units) of charge power in the batteries. Once the batteries are fully charged, they are able to discharge only 36 units (60% of 60 units).

Conclusions and Recommendations

Establishing Internet access in rural areas in an affordable and sustainable manner is clearly not a simple task. The following aspects of connectivity and energy supply and steps can guide organisations engaged in rural access activities.

Connectivity and Internet access

Carry out bandwidth needs analysis and compare options. Connectivity and Internet access can be achieved in many ways based on technical requirements and costs. The needs for bandwidth may vary. It is therefore recommended that an organisation carries out a thorough assessment of present and future needs and compares the various options available before it makes any investment. A realistic evaluation of the actual bandwidth needs can result in considerable cost savings and directly affects the sustainability.

Cost of Internet access. The cost of Internet access in Ghana is high, and even higher to send connectivity to rural areas. Copper is the common way to connect to the Internet in Ghana but this is non-existent in the rural regions. VSAT and long distance wireless broadband is the most common way to send Internet to rural areas. Investment costs vary between $5,500 and $8,500 for both options and a monthly fee of $600 and $2,350 for satellite, depending on bandwidth. For Wireless broadband, a monthly fee of $140 and $850 for shared access and $350 and $1,850 for dedicated access to the Internet is charged, depending on bandwidth. Maintaining the equipment is problematic and costly, which reduces profitability. ICT training in rural areas would also be needed.

Share costs. As costs for connectivity to the global Internet via V-SAT are high it is recommended to optimise use of the bandwidth and explore options to offset the high monthly costs, for example by sharing connectivity or generating income via VoIP. For example, the Wireless Ghana project uses the shared model to send connectivity through a mesh wireless network to several other communities in the Eastern region of Ghana.

Monitor and control the use of bandwidth. Tools to monitor the provision of bandwidth are useful for claims to providers regarding the bandwidth that is actually delivered compared to the amount that has been contractually agreed. Tools to regulate bandwidth use are crucial to optimise usage during the 24-hour availability of the connection. This can be done using pre-set policies. Finally, if a problem with the network does arise, tools exist that can help to identify the origin of the problem and assist with troubleshooting.

Reduce costs through collective action. Rural organisations could collectively bargain for connectivity. For example, if 20 telecentres buy Internet access individually they would pay much more than if they joined together as a group and then negotiated with an ISP for a larger purchase.

Energy

Rural energy is crucial for rural access. Rural access can be severely undermined by an inadequate or unreliable power supply. This should be factored into all plans to establish connectivity in rural areas. Many options exist for power supply, some of which are listed in this report. A sound energy plan and implementation process will save costs and troubles at a later stage. It also reduces the risk of damage to equipment. The use of renewable energy offers environmental and socio-economic benefits for the local community. A decentralised or local power supply will help to extend the operating hours and services of your telecentres.

Calculate and reduce energy needs. It is necessary for any power supply or back-up system to know the power consumption. This report gives guidelines on how to calculate this. Power needs can be reduced by using energy-efficient equipment such as flat-screen monitors rather than old screens and laptops as opposed to PCs.

Ensure power back-up and fluctuation control. If power from the grid is used, this has to be consolidated with energy back-up solutions and probably alternative power-supply solutions. It is recommended to install a UPS that absorbs acute power cuts. The capacity of the UPS should match the needs to continue operating the system during grid power-cuts. Simple UPSs that absorb power-cuts for a few minutes are rather cheap, around $60-$80. Extended power back-up solutions are rather costly and range from US$2,000 to US$5,000. It is advisable to purchase a surge arrestor that eliminates peaks in power which can damage equipment.

Use common energy-batteries for energy storage. Most systems need batteries to store the energy generated and release it during other times. Normal energy-storage batteries are cheaper but do not last as long as the deep cycle batteries which cost twice as much. Car batteries are not recommended because they need regular maintenance and produce corrosive fumes. Sealed maintenance free batteries are recommended and cost around US$300 for a 120AH piece.

Solar panels. These are commonly available in Ghana. They require little maintenance once installed. The cost of a 240 Watt solar panel that provides 6 hours of use for a 40 Watt bulb is, on average, US$450.

Wind. These are relatively new types of energy in Ghana. It is recommended that these alternative sources of energy are piloted and closely monitored, documented and shared in order to support connectivity and access in rural areas. It will be particularly ideal to pilot them in the coastal areas of the country where it is always windy.

Annex 1: Useful addresses

#	Company Name	Address	Type of service	Location	Telephone (+233)	Fax (+233)
1	1st African Communications Co. Ltd	P. O. Box 1574	ISP	No. 11, 5th Lane Osu RE	21 778 665 21 783 330 20 811 5110	
2	2A Communications	P. O. Box DS 574 Dansoman, Accra	ISP		21 812 021	21 810 023
3	Acae Company Ltd	P. O. Box 105, La-Accra	ISP/Spread Spectrum 2.4 & 5.8GHZ	La	21 777 988 21 782 7971	
4	Accelon Gh Ltd (IP Direct Gh Ltd)	PMB CT 248, Cantonments, Accra	ISP/Public data and VSAT hub		21 663 450	21 663 378
5	Access Africa International	P. O. Box 589, Accra	ISP	Lartebiokorshie	21 663 494	
6	Advanced Voice Systems Ltd	P. O. Box 18834, Accra Central	ISP	Accra	21 303 888 243 862 312	
7	Africa Express Communications Network	P. O. Box OS 2244, Osu	ISP/Spread Spectrum 2.4 & 5.8GHZ	Accra	21 301 391	21 311 726
8	Africa Netcom Ltd	P. O. Box KIA 9508, Accra	ISP/Public Data/VSAT			
9	Africa Online Ghana Ltd	P. O. Box STC 84 Kaneshie, Accra	ISP/Public Data/ Spread spectrum	5th Floor, GCB Towers, Kwame Nkrumah Circle	21 246 065/9	21 246 182
10	African Business Associates (Gh) Ltd	P. O. Box MP 467, Mamprobi, Accra	ISP/Public Data/ VSAT	Accra	21 310 480	21 313 337
11	African Soft Ltd	P. O. Box SD 46, Sports Stadium, Accra	ISP/VSAT	No. F459/4 Nyaniba Estates, Osu Accra	21 257 222	21 257 220
12	Africanus Net Limited (Giant International)	P. O. Box CT 2277 Cantonments; Accra	Public Data/ISP VSAT(2.4GHz/ 5.8GHz) VSAT HUB	Suite 306, Aviation House; Aviation Road, Accra	21 782 031 20 201 3076	21 779 049
13	AfriNet Communications Ltd (Regimanuel Ltd)	P. O. Box CT 1167, Cantonments	ISP/Public Data	Ground Floor, Regimanuel Gray Bldg, No. 2 La Bypass, La		
14	Agogo Information Tech. Centre (Digital	P. O. Box 16518, KIA Accra/ P. O. Box 1	ISP	Agogo Ashanti	51 881 213 21 255 65-	21 255 874

	Development Partners, Inc)	Agogo, Ashanti				
15	Agritel Limited Distance Learning	P. O. Box AN 6357, Accra North	ISP		244 375 962 21 628 151	21 221 183
16	Alltell Ltd	P. O. Box 10011, Accra North	ISP/Public Data services	Technology House, Kotobabi	243 132 244	21 250 888
17	Alpha Wireless Co. Ltd	P. O. Box BT 133, Tema	ISP/VSAT	Tema	22 310 388 22 307 338 244 533 884	
18	Altec Systems Limited	P. O. Box AN 6504, Accra	Public Data/ISP VSAT(2.4GHz/ 5.8GHz) VSAT HUB	Ring Road Central, Nr K Nkrumah Circle	21 256 630	21 255 919
19	America Telecom Systems (GH) Ltd	P. O. Box 9764, Airport, Accra	ISP/Public Data services	Trinity House, Ring Road East Osu	21 228 290	21 761 707
20	Ameritel Co. Ltd	P. O. Box 4848 Accra	ISP		21 401 982	
21	Arrow Networks Systems Ltd	No. 7 12th Avenue, Abeka Main Rd, Tesano	ISP Public Data 2.4GHz 8 pairs UHF (400MHz) 1 pair of VHF Freq. with 25 MHz	244 331 685		
22	Ashesi University College	PMB CT3, Cantonments, Accra	ISP	No. 87, 3rd Norla Extension, North Labone	21 777 902 21 784 766/7	21 784 768
23	Atelco Ghana Limited	P. O. Box KD 311, Kanda, Accra	ISP/VSAT/ Public Data	Hse No. C 846/3 Mango Tree Ave, Asylum Down, Accra	21 241 214 244 606 889	21 241 214
24	B.P.P. Teletech Black Pearl Project Ltd	P. O. CE 11150, Tema	ISP	Hse No. V29, C9 Tema	22 304 390	22 304 390
25	BBL Ltd	P. O. Box 9257, KIA Accra	ISP	74 Farrar Avenue, Opp Trust Towers Adabraka	21 241 111	21 241 312
26	Bertek Network Solutions Ltd	P. O. Box 4418, Kumasi	ISP/VSAT		244 380 131	
27	Besnet Company Limited	P. O. Box OS 1779, Osu Accra	ISP	Antrak House, Osu	21 768 324	21 773 964 21 772 487
28	Bhext Company Ltd	P. O. Box KIA 30491, Accra North	ISP	Mensah-Sarbah Hall, Accra	21 232 760	

29	Broadspectrum Ltd	P. O. Box 12343, Accra North		Accra	21 701 0465	21 701 0965
30	Business Ghana Internet Services	P. O. Box MP 1219 Mamprobi, Accra	ISP/VSAT Spread Spectrum 2.4 & 5.8GH	Accra	21 672 289 20 816 6150 244 373 306	
31	CATV Ltd	P. O. Box CO 3057, Tema	ISP	E 7 Sakumono Flats, Tema		
32	Cleartel Direct Communication	P. O. Box 113, Johannesville Ofankor, Accra	ISP	Hse. No. D623/3 Brewery Road Adabraka	243 680 006	
33	Comsys Ghana Ltd	P. O. Box 11322, Accra North	ISP/VSAT Spread Spectrum 2.4 & 5.8GHZ		21 251 097 21 250 757	21 254 540
34	Daigoh Shoji Partners Ltd	C 90/24 West Airport Res PMB CT 200 Cantonements, Accra	ISP	C 90/24 West Airport Residential Area, Accra	21 785 683	21 785 684
35	Danjude Company Ltd	P. O. Box AN 19400, Accra North	ISP/Public Data VSAT	8th Floor GCB Towers, Kwame Nkrumah Circle	21 255 521-4	21 255 521
36	Datanet Communications Ltd	P. O. Box LG 707. Legon, Accra	ISP/Public Data Network/VSAT	Accra		
37	Easy Net Company Ltd	P. O. Box AN 6564, Accra	ISP	Accra		
38	E-Link Technologies	P. O. Box 9771, KIA; Accra	ISP/ Public Data/ VSAT	Nyaniba Estate, Osu	21 762 015	21 762 449
39	Engineering Services & Systems Ltd	P. O. Box 2007. Cantonments, Accra	ISP/Public Data Network	Premier Towers, Suite 10B, Pension Street, Accra	21 678 080	21 678 090
40	Equitele Gh Ltd	P. O. Box 16520 KIA, Accra	ISP	Trade Fair Site, Pavilion Q	21 701 0465	
41	Eva-Asa Company Ltd	P. O. Box 2393, Sunyani, Brong Ahafo	ISP/VSAT		61 267 32/61 265 56 20 811 800 48 244 410 048	61 265 56
42	F Giant Broadcasting Ltd	P. O. Box 5867, Kumasi	ISP	Prempeh Hall, Maxwell Road	51 340 58	51 340 97
43	Faith Telecom Ltd	P. O. Box CT 1412, Cantonments, Accra	ISP/VSAT/Public Data	Accra	21 250 944	21 250 945
44	Farcom Investment Ghana Ltd	P. O. Box 2627 Accra	ISP/VSAT/ Spread Spectrum	Accra		

			2.4 & 5.8GHZ			
45	Gatel Communications Ltd	P. O. Box CST 9090 Community 7, Tema	ISP	Community 7		
46	Gateway Telecoms Ltd	P. O. Box C 766, Cantonments	ISP	Accra	244 257 104	22 204 374
47	General Communications Co. Ltd	P. O. Box GP 231 Accra	ISP/VSAT	Hse. No. 5 8th Ave, West Ridge, 2nd Bldg on right after EC Head Office.	21 683 854/5 243 259 038	
48	Geosat Technologies Ltd	P. O. Box B 525, Tema	ISP		22 202 856	22 202 856
49	Ghana Classified	P. O. Box 1323, Accra	ISP	57 East 11th St, Suite 9 New York, NY 10093	21 232 700	21 235 334
50	Ghana Net	P. O. Box C 2325, Cantonments, Accra	ISP/VSAT	55 Faanofaa Road Kokomlemle		
51	Goldern Beach Hotel Gh Ltd	P. O. Box 3000 Accra	ISP/Spread Spectrum 2.4 & 5.8GHZ	Accra	21 781 621	21 768 947
52	Gold-On-Line Ltd	P. O. Box 16417, Airport, Accra	ISP/ Public Data/ VSAT	Aviation Road	21 761 712 21 778 670	21 777 527
53	Gongon Communications	P. O. Box 15172, Accra North	ISP	Jesus Cares Building, Ring Road 276A Ward O Block, Accra	21 665 830	21 663 935
54	Grasrut Ventures	P. O. Box 234, Tamale	ISP/VSAT	Tamale	71 236 14	71 236 90
55	Greenfield Media Limited	P. O. Box CT 3673, Cantonments, Accra	ISP		21 250 844 21 701 0149	21 250 844
56	Grobohama Ltd (Groboplus)	P. O. Box CT 488, Cantonments, Accra	ISP/VSAT	75-77 Ring Road Central, Asylum Down, Accra	21 247 972 21 252 100 21 251 900	21 249 207 21 247 971
57	H.I.M Solutions Ghana	P. O. Box 20012, Accra	ISP/VSAT/ Spread Spectrum 2.4 & G.8 GHZ	No. 11 Lamb Street, Asylum Down Accra	21 257 400 21 257 743	21 257 410
58	Horizon Network Services	P. O. Box 8914, Kumasi			20 811 6755	
59	Horizon Telecom Co. Ltd	P. O. Box CT 3315, Accra	ISP/VSAT	Accra	21 508 431 244 479 479	

60	Hyperlink Network System	P. O. Box 16110, KIA Accra	ISP/VSAT/ Public Data	Blk 8 Science Museum , off Banson Road	21 230 174 21 230 125	21 230 261
61	Hyspec Ghana	P. O. Box SC 486, Community 1, tema	ISP/VSAT/ Spread Spectrum 2.4 & 5.8GHZ		21 770 434	21 768 867
62	Infinite Stream (Valve Data Ghana Ltd)	PMB 208, Accra North	ISP/Public Data/VSAT	Rawa Plaza, Mango Tree Avenue Asylum Down, Accra	244 683 610	
63	Innetix Ghana Ltd (IGL)	P. O. Box 15084, Accra North	ISP		21 701 2001	21 701 2005
64	Intercom Data Network Gh	P. O. Box 16439, KIA, Accra	ISP	Accra	21 408 311	21 408 310
65	Intercom Programme & Manufacturing Co. Ltd	P. O. Box 7617, Accra North	ISP	62 Kojo Thompson Rd, Rana House Adabraka Accra		
66	Intercontinental Calls Ltd	P. O. Box CS 8282, Tema	ISP	Hse No. U 51, Sir Arku Korsah St. C8 tema	22 310 928/9 244 210 525	
67	Internet Business Centres (Gh) Limited	P. O. Box CT 686, Cantonments, Accra	ISP		21 762 083 21 701 2260	21 778 422
68	Internet Data Network	P. O. Box AD 84, Adabraka, Accra	ISP	25 Mushroom St. Ghana Telecom Dome Exchange, Accra		
69	Internet Ghana Ltd	P. O. Box GP 90, Accra	ISP/VSAT Spread Spectrum 2.4 & 5.8GHZ	Mama Abui Plaza Hall Avenue, Adabraka	21 251 871-6	21 251 877
70	Into Africa Investment	P. O. Box 9732, Osu RE Accra	ISP	SRS/029, Eleventh Lane, Opp US Embassy	21 774 587 21 773 153 277 403 346	
71	IT Services Limited	P. O. Box 15239, Accra North	ISP/Public Data services	No. 1 1st Dade Walk, North Labone Est.	21 774 117	21 774 117
72	Java Net Limited	P. O. Box 1632, Accra North	ISP/Public Data 2.4/58GHz	1st Floor, Teachers Hall Annex, Education Loop		
73	Jtel Technologies	P. O. Box CT 3249 Cantonments, Accra	ISP	16 Linda Street, East Legon	21 507316 20 815 4920	21 763 647
74	Kalss Inn Ryma	East Legon, Abedi Pele	ISP/Public Data	Lagos Avenue	21 517 746	21 517 745

	Telecommunications Ltd.	Road, Accra	/VSAT/ Spread Spectrum 2.4 & 5.8GHZ	38A East Legon, Accra	21 518 214/5	
75	K-Computer Services	P. O. Box 0641, Osu Accra	ISP Public Data Network	Silicon House, No. 4 North Ridge Crescent, Accra		
76	Kelstone Gh Ltd Netin Ghana Ltd	P. O. Box OS 1560, Airport Accra	ISP	T17 Aduman Rd Tesano Accra		
77	Kina Telecom Limited	P. O. Box 241, La-Trade Fair	ISP/Public Data	Accra	21 665 113	21 678 952
78	Konetme Limited (formerly Link to Link Solutions)	P. O. Box 1A 95, Accra North	ISP	45 Kwame Nkrumah Ave; 3rd Suite 313	244 365 457 244 370 363	
79	Koo Consult Limited	P. O. Box An 7456, Accra North	ISP/Public Data	46A 4th Close Akosombo Road, Airport Residential Area		
80	Lamdelta Communication Ltd	P. O. Box 146, Sekondi	VSAT/ISP Spread Spectrum 2.4 & 5.8GH	Hse. No 14 Bakaekyir, Sekondi	31 465 67	31 465 67
81	Legendary Telecom Company	P. O. Box 11552; Accra North	ISP/Public Data/VSAT	Accra	21 812 353	21 812 187
82	Linkserve Ghana Ltd	P. O. Box 18343, Accra North	ISP	64 Mango Lane, Asylum Down	21 778 205	
83	Luxe Telecom Ghana Ltd	P. O. Box MP 1140, Mamprobi, Accra	ISP/ Public Data 2.4/5.8GHz	Accra		
84	Mac Telecom	P. O. GP 18220, Accra North	ISP		21 669 532 21 403 438	21 234 663
85	Mex Multimedia	P. O. Box 0629, Takoradi	ISP	Cocoa Villa Road, Newsite Takoradi	31 205 76	
86	Ministry of Defence (Directorate of Communications)	Directorate of Communications, General Headquarters, Burma Camp, Accra	ISP	Burma Camp	21 777 528	
87	Mobicall Ghana Ltd	P. O. Box 4030, Accra	VSAT	CT 144 Cantonments, Accra	21 229 160 21 222 846	21 226 547
88	Nas International Global Networks	P. O. Box KA 30682, Airport, Accra	ISP	9th Floor GCB Tower, Kwame Nkrumah Circle	21 701 2800/2	21 701 2803
89	Natel Ltd	PMB CT 309,	ISP	5th Floor,	244 283 262	21 812 036

		Cantonments, Accra		Heritage Tower		
90	National Catholic Secretariat	Secretary General's Office, Century House; P. O. Box KA 9712, Accra	ISP	Secretary General's Office, Century House Near Tetteh Quarshie Overpass	21 502 148 21 500 491/2	21 502 149 21 500 493
91	NB Teleworld Ltd	P. O. Box AN 15497, Accra North	ISP/Spread Spectrum 2.4 & 5.8GHZ	1st Floor Women's World Bank, Opp Ferrotal Ghana, Avenor		
92	Nel Telecommunications Ltd	P. O. Box AN 6488, Accra North	ISP	Maame Yaa Place	21 221 434	21 223 208
93	Net Access Ltd	P. O. Box CT 2653, Cantonments, Accra	ISP/VSAT	Accra	20 201 2998 244 230 225	
94	NetAfrique Dot Com Ltd	P. O. Box TN 1293 Accra	ISP/ Public Data/ 2.4GHz/5.8G Hz	4th Floor Southern Wing, Ghana Multimedia Centre, High St, Accra	21 688 699	
95	NetPartners Limited	P. O. Box 8074, Accra North	ISP	Ring Road Central, 5th Crescent, Accra	21 258 700/58	
96	Netplux Ltd (Afriweb)	P. O. Box CT 2057, Accra	ISP/VSAT	4 Castle Royalt Rd, Kokomlemle Accra		
97	Network Computer Systems	Private Mail Bag, Osu Accra	ISP	34 Church Crescent, Labone Accra	21 779 321/2 21 762 170	21 773 372 21 762 173
98	NGN7 Ltd	PMB C-95, Cantonments	ISP	Accra	244 331 757	
99	NTS Telecom Ghana Ltd	P. M.B 16, Medina Accra	ISP/ Public Data/ VSAT	205 Lagos St, East Legon	21 510 765/6	21 510 996
100	Omega Computer & Communication Services	P. O. Box 1255, Tema	ISP		22 210 235 20 811 0603	
101	Omega Technologies Limited	No. 10 Chestnut Road Silver Bells, Regimanuel Est; East Airport, Accra	ISP/VSAT	No. 10 Chestnut Road Silver Bells, Regimanuel Est; East Airport,	21 811 932	

				Accra		
102	OralCom Ghana Ltd	P. O. Box KN 379 Accra	ISP	Accra	244 837 950 277 191 554	
103	Phoenix Network (Subsidiary Company of Phoenix Media Publishing)	P. O. Box AH 1151, Achimota, Accra	ISP/VSAT/ Public Data	Accra	21 783 531 244 642 822 244 223 964	
104	Procon Gh Ltd	P. O. Box KA 16271, Accra	ISP/Public Data/VSAT	Accra	21 779 374 21 760 350	21 – 772 053
105	Ray Foundation Ghana	c/o Ernst & Young Plc. White Ave; Airport Area	ISP		21 779 867	21 772 008
106	Red Mango Ltd	PMB CT 121, Cantonments, Accra	ISP		21 246 854	21 242 140
107	S. D. N Ghana Ltd	P. O. Box STC 84, Kaneshie, Accra	ISP	5th Floor, GCB Towers, Kwame Nkrumah Circle	21 246 108	21 246 132
108	S. N. I.	P. O. Box 11323, Tema	ISP	Tema	22 302 641 20 813 0605	22 226 286
109	Satconsult Ltd	GPO 21024, Accra	ISP	Accra	244 370 363 244 365 457	
110	Smart Call Ltd	P. O. Box KN 810, Accra	ISP	Hse No. F205/4 Kalamzo, Agbaame St, Ako Adjei, Osu	21 762 114	21 765 456
111	Spectrum International Ltd	P. O. Box CT 2007, Cantonments, Accra	ISP/Public data	3rd Floor Akai Hse No. 38A/1 Ringway Est. Osu	21 763 807	21 216 963
112	Sphinx Tele-Systems Ltd	P. O. Box CT 159, Cantonments , Accra	ISP	Accra	22 301 279	21 241 313
113	Springfield Africa ltd	P. O. Box CT 4626, Accra	ISP/VSAT	18, Third Close, Airport Residential Area	21 777 494 21 780 313/4	21 775 380
114	Springs Engineering Systems	P. O. Box OS 2046 Osu Accra	ISP/VSAT Spread Spectrum 2.4 & 5.8GHZ	2nd Floor Sotrec Bldg, F235/2, Abebresem Street	21 786 258 21 786 259	21 786 284
115	Startel Solutions Ltd	P. O. Box 16409, Airport, Accra	ISP	Accra	21 669 816 21 668 434	21 667 277
116	Storm Net Systems Ltd	P. O. Box 17244, Achimota	ISP	No. 12 St. Anthony, Achimota	21 402 252 244 184 313	

				Residential Area		
117	Swift Sourcing Solutions	P. O. Box 453, Accra	ISP	4 Liberation Road	21 761 746	21 775 480
118	Tandem Networks Ltd	P. O. Box CT 340, Cantonments, Accra	ISP	Accra	21 51795 244 323 284 20 201 2931	21 51795
119	Tech Zone Advanced Technologies	P. O. Box ST 321 STC Accra	ISP/VSAT	Kaneshie First Light	21 256 720-2	21 256 724
120	Telecom Information Systems Africa (TELISAF)	P. O. Box CO 2419, Tema	ISP/Public Data/VSAT	F 142/6 La Crescent Road, Labone	244 727 240 244 615 253 21 813 741	21 813 742
121	Teledata ICT Ltd	P. O. Box 8839, Accra North	ISP/2.4GHz/ 5.8GHz	Ring Road Central	21 238 662/3 21 701 0172/3	21 238 494
122	Tin-Ifa Ghana Ltd	P. O. Box 15201, Accra North, Accra	ISP/ VSAT	C 354/3 Laimomo St, Asylum Down Accra		
123	Tonayaa Business Centre Ltd	P.O. Box 1824, Kaneshie	ISP	Hse. No. CO 266/15. Alajo, Accra	21 238 211	21 238 211
124	Transatlantic Network Limited	P. O. Box LT 292, Laterbiokorshie, Accra	ISP/VSAT	2nd Floor, Trinity House, Ring Road East		
125	U2 Online Communications Ltd	P. O. Box AN 12609, Accra North	ISP/ VSAT Spread Spectrum 2.4 & 5.8GHz Public Data Network & Spectrum in 2GHz Bandwidth	Accra	21 236 150	21 229 314
126	United Business Systems Ltd (Gh)	P. O. Box 1842, Kaneshie Accra	ISP	House No. G92, 10th St. Club 250 Rd. 1st Stop Roundabout Dansoman, Accra	21 312 855/54	21 226 563
127	United Technology Company	P. O. Box 2266, Accra	ISP	Accra	21 763 449	21 763 449
128	Universal Cyberlinks	P. O. SK 717, Sakumono Tema	ISP/VSAT	Accra	21 811 395	21 811 406
129	Usan Ghana	P. O. Box CT 35, Cantonments, Accra	ISP		21 779 502 21 779 501	21 779 500 21 240 700

					21 774 069	
130	Voltacom (VRA)	P. O. Box M77, Accra	ISP/ VSAT		21 221 124 21 664 941	21 662 610
131	Warren Development Corporation Ghana Ltd	P. O. Box OD 532 Odorkor, Accra	ISP/VSAT/ 2.4GHz/5.8GHz	Accra		
132	WaveLinks Limited	P. O. Box 10094, Accra North	ISP	Accra	21 773 334 21 502 332	
133	West Africa Network Ltd	P. O. Box AD 309, Adabraka, Accra	ISP/ VSAT/ Spread Spectrum 2.4GHZ	No. 63 Patrice Lumumba Link, Airport Residential Area.	21 776 402 243 337 777 244 330 728	
134	Wice-Net Ghana Ltd	P. O. Box CT 3038, Cantonments, Accra	ISP	# 4, Ghana Multimedia Incubation Centre. Ghana House. High St, Accra	21 774 462	21 518 111
135	Worldlink Comm Ltd	P. O. Box CT 3677, Cantonments, Accra	ISP/VSAT		21 768 357/8	21 771 663
136	Worldstar International Ltd	P. O. Box 6784, Accra	ISP		21 778 506	21 778 508
137	Zytec Telecom ltd	P. O. Box 15175, Accra North	ISP	Shop 7 Kingsway Bldg; Kwame Nkrumah Avenue Swanzy Shopping Arcade	21 256 884/5	21 256 987 21 2333 915

Annex 2: Profiles

About the author

Jonnie Akakpo has over twenty (20) years of teaching, training and consulting experience in Information and Communication Technologies (ICTs) and Organisation Development (OD). He is an expert in forecasting workforce requirements, establishing and redesigning organisations; influencing and leading the work of individuals and groups in change initiatives with a systematic injection of ICT interventions.

About Consolidated Solutions Limited (CSL)

Jonnie Akakpo works with Consolidated Solutions Limited (CSL); a multi-disciplinary firm that works from the capital city, Accra, in Ghana. CSL facilitates change in diverse areas of individual and organisational learning and development. CSL also employs contemporary ICTs for enhanced organisational productivity and effectiveness.

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About GINKS

The Ghana Information and Knowledge Sharing Network (GINKS) is a constitution of a broad range of people drawn from various fields of endeavour but mainly involved in Information Communication Technologies (ICTs) and sustainable Development. GINKS acts as a linchpin that streamlines all disjointed ICT projects, initiatives and programs in a way that provides solutions to challenges and problems in the ICT environment. More information: www.ginks.org.

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About IICD

The International Institute for Communication and Development (IICD) helps developing countries to realise sustainable development by harnessing the potential of information and communication technologies (ICTs). The driving force behind IICD's activities is that local 'change agents' themselves identify and develop proposals for realistic ICT applications - local ownership forms the essential basis for sustainable socio-economic development. Acting as a catalyst, IICD's three-pronged strategy is mainly delivered through a series of integrated Country Programmes. First, IICD facilitates ICT Roundtable Processes in selected developing countries, where local stakeholders identify and formulate ICT-supported policies and projects based on local needs. Second, working with training partners in each country, Capacity Development activities are organised to develop the skills and other capacities identified by the local partners. Third, IICD draws on its global network to provide information and advice to its local partners, also fostering local information exchange networks on the use of ICTs for development. The best practices and lessons learned are documented and disseminated internationally through a Knowledge Sharing programme. In support of these activities, IICD invests in the development of concrete partnerships with public, private and non profit organisations, thus mobilising knowledge and resources needed by IICD and its local partners. Country Programmes are currently being implemented in Bolivia, Burkina Faso, Ecuador, Ghana, Jamaica, Mali, Tanzania, Uganda and Zambia. More information: www.iicd.org.

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