CHAPTER 9

Research and Education Network in Ghana: Promoting ICT in developing countries through research cooperation[1]

Reza Tadayoni & Knud Erik Skouby

1. Introduction

It is generally acknowledged that information and communication technologies (ICTs) have generic characteristics, i.e., that these technologies by and large are the basis for the production, distribution and consumption processes in contemporary societies. This development is associated with concepts such as pervasive computing and an emerging new techno-economic paradigm with convergence between information technology (IT), computing and mass media as a driving force. To reap the benefits of this, many industrialised and industrialising states since the mid-1990s have produced one or several plans for the Information Economy. At the European level, the European Union White Paper on growth and competitiveness, the Bangemann Report and Towards the Information Society were issued in 1993, 1994 and 1995 respectively. In other parts of the world, countries such as the US, Japan, Singapore, South Korea, Canada and Australia have all published national plans during these years, as have some developing countries in Asia and Africa, such as Malaysia, Thailand, the Philippines and Ghana.

An analysis of these plans shows uniformity in expectations and goals. ICT is expected to revolutionise ways in which we produce, the way we distribute the results of production and patterns of consumption. In reality many of the plans do not proceed further than general statements, but all of them include an explicit political determination to be at the forefront of the technological development initiated by ICT. This tendency is very pronounced in most of the developing country cases, including the Ghanaian plan – *Ghana 2020*. Industrialised countries having formulated more specific strategies, are in reality less concerned with the revolutionary potential of ICT than with strengthening existing industrial strongholds, i.e., traditional industrial policy (Henten et al. 1996; Henten and Kristensen 2000). The impact of ICT policies in different countries and regions has been subject to research studies with impact of political willingness being shown as vital. There are however other parameters, such as poverty levels and cultural issues that also influence penetration and use of ICT (Aizu 2002; Selhofer and Mayringer 2001).

The relatively low income levels in the developing countries generally explain the low level of ICT development. To cope with this, foreign direct investment (FDI) has been suggested as a method of promoting ICT development in developing countries (Zhu 2001). In this project, a different approach is suggested, for which the development of ICT is included as a part of foreign assistance to developing countries – for research cooperation and assistance. The approach has generally been considered as relevant by different world organisations and cemented by the establishment of the UN task force for ICT development in developing countries.

To explore specifically the potential for ICT as related to general social priorities such as free access to information and its use in education and research, a team of Ghanaian and Danish researchers and practitioners have been working since 1996 to implement ICT in these areas. The focus has been on applications and users testing different technical solutions, their costs and applicability.

Work has so far been organised within and around two projects, the Technology Assessment Project (TAP), sponsored the Danish International Development Assistance program (Danida) and the Interlibrary Lending and Document Delivery in Developing Countries project sponsored by the International Federation of Library Associations and Institutions (IFLA) and Danida.

One of the key objectives has been to establish a research and education network connecting different universities and research institutions within Ghana and also beyond via the Internet. A combination of HF, VHF and microwave solutions has been used to implement connectivity between university libraries dispersed over a wide geographical area and with different distances to the University of Ghana in Accra. The university was then connected to the Internet backbone through a VSAT connection grounded in Denmark.

The remainder of this section provides a brief overview of Ghana. In Section 2 we describe the case and identify the drivers, barriers and lessons learned. Section 3 outlines the implications of the case on research and education in Ghanaian universities and research institutions. Section 4 concludes with comments on future perspectives.

1.1 Ghana in brief

The Republic of Ghana, formerly known as the Gold Coast, lies on the coast of West Africa. Its population of 19.4 million consists of over 50 different ethnic groups speaking various languages and dialects. Despite its great cultural diversity, Ghana has avoided any major ethnic conflict throughout its 44-year history as an independent nation. While English is the official language, the major dialects of Twi, Ga, Fanti, Ewe and Hausa are prevalent. Ghana's main urban centres are Accra (the capital), Kumasi, Cape Coast, and Takoradi.[2]

The map of Ghana is shown in Figure 1. Bold arrows indicate the locations that took part in the project described in this chapter.

The five public universities involved in project are:

- University of Ghana at Legon;
- Kwame Nkrumah University of Science and Technology at Kumasi;
- University of Cape Coast;
- University College of Education at Winneba; and
- University of Development Studies at Tamale.

The University of Ghana is the oldest and largest of the five, founded in 1948 as the University College of the Gold Coast, and originally an affiliate college of the University of London, which supervised its academic programs and awarded degrees. It gained full university status in 1961, and now has nearly 24,000 students.

In addition to the public universities there are also a number of private universities and public and private research institutions. The project did not include private universities but one of the research institutions, the Council for Scientific and Industrial Research (CSIR) located in Accra, was heavily involved in the project.

1.2 Overview of ICT development in Ghana

Figure 2 shows the penetration of mobile and fixed services in Ghana, which has been quite low. However, growth in the mobile sector has had radical impact on this development.

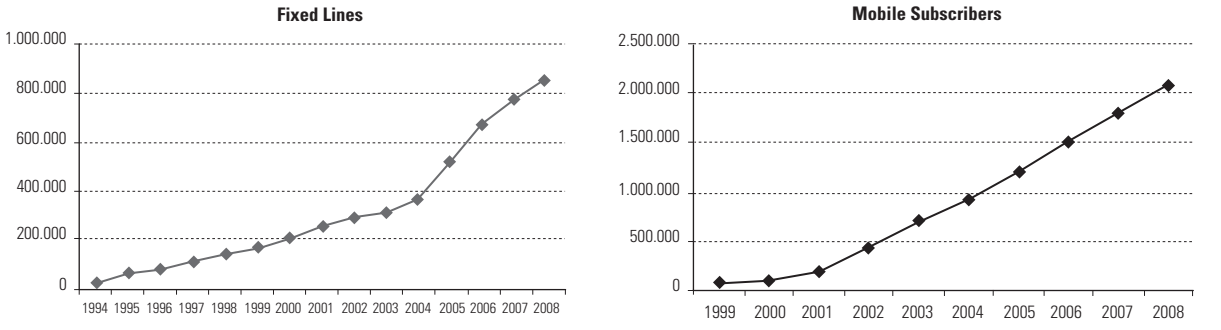
Figure 3, shows the continuation of this development, according to estimates based on general economic stability,

Figure 1. Map of Ghana

Figure 2. Mobile and fixed line subscribers

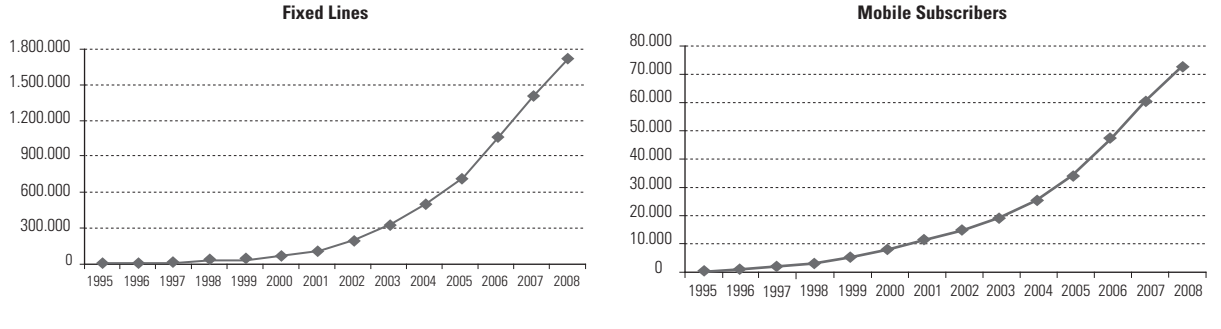
Source: Wilkofsky Gruen Associates (2005).

Figure 3. Estimates of development of mobile and fixed line subscribers



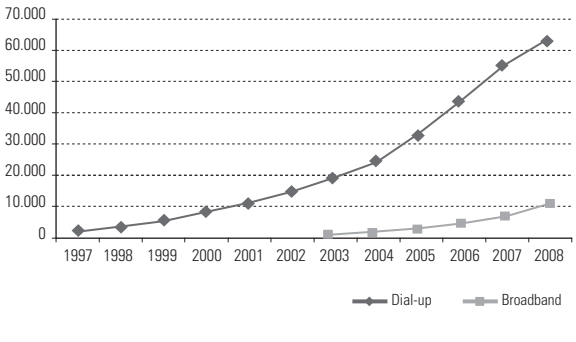
Source: Wilkofsky Gruen Associates (2005).

Figure 4. Internet users and subscribers



Source: Wilkofsky Gruen Associates (2005).

Figure 5. Internet users and subscribers by category



Source: Wilkofsky Gruen Associates (2005).

inflation coming down and the relative stability of the Ghanian currency (cedi), enabling Ghana Telecom to obtain overseas loans to keep their current plans.

Figures 4 and 5 show that penetration of Internet subscription is not very high and is mainly dominated by dial-up connections. However, Internet use is relatively high, due to the availability and popularity of Internet cafes and telecentres.

Broadband accounts for only a marginal portion of the Internet landscape. This is due to the late availability of broadband offerings for residential customers and their high cost. In mid-2006, Ghana Telecom began a massive marketing campaign to create awareness and attract new subscribers. In addition to Ghana Telecom's DSL technology, there are also a number of WiFi and other wireless operators.

2. Research and Education Network in Ghana

This section begins with some historical background for the initiatives and then describes the library project and the research and education network. Finally, the experiences and the drivers and barriers are outlined.

2.1 Background

In May 1996, a USAID mission to West Africa explored possibilities for providing Internet connectivity to the university communities. The primary purpose of the mission was to determine the state of readiness for Internet connectivity in different countries and to assist in devising plans for establishing such connectivity including funding. Assessments of existing telecom facilities were also made. In the case of Ghana it was concluded that additional investments were needed as a precondition for establishing Internet connectivity and that this was likely to be met through cooperation with Danish researchers.

Following this mission, as documented in the so-called Sadowsky report, USAID agreed to finance Internet connectivity under its policy derived from the Leyland Initiative, provided that necessary data and telecom infrastructure requirements were made available without assistance from USAID.

Soon after the USAID agreement to finance Internet connectivity, the University of Ghana in close cooperation with the Center for Tele-Information (now called the Center for ICT – CICT) at the Technical University of Denmark submitted a proposal for a New Data and Communications Infrastructure to the Danish Embassy in Accra. In 1998, the Danish Embassy in Ghana agreed to finance the backbone part of the new infrastructure – a network ring, proposed by the Center for Tele-Information.

In parallel with these projects, activities for a project sponsored by IFLA and Danida were directed towards establishing inter-lending facilities for Ghanaian university libraries enabling them to use library resources in Western Europe/ Denmark.

It was decided to form a collaboration between the CICT projects and the IFLA project by including a technical task in the IFLA project. This resulted in a proposal for an electronic library network. This network was aimed at establishing connection between the five regional research libraries (Cape Coast, CSIR Accra, Kumasi, Tamale and Winneba) and the Balme Library at the University of Ghana. The network would have Internet access via the Balme connection.

The Library Network was planned with a shortwave/HF-solution as the core technology, but as the project is a pilot for future international implementation it was foreseen from the beginning that other technologies would also be introduced and tested. Currently the network is established as a mixed solution using shortwave (HF), VHF and microwave connections to the Balme Library.

From the beginning it was considered as a precondition for the project that it demonstrate long-term financial self-sustainability. To assure this, firm commitments were sought from organisations willing and able to pay contributions adding up to cover the costs associated with the project. These included not only the running communication costs, but also administration, technical maintenance and development of the system.

It turned out that the slowness (and the low quality of service) of the Internet connection was a major bottleneck for taking advantage of the new possibilities these initiatives enabled. To solve the problem a new project was proposed by CICT to establish a research and education network (R&E Net) in Ghana with direct connectivity to the Internet backbone. The system was implemented with the intention of connecting as many Ghanaian universities and research institutions as possible to this network. The capacity of the network was to be increased as the demand increased.

There emerged, however, also regulatory, technical and organisational barriers in the process of establishing the infrastructure. The major regulatory barrier in the process was frequency assignment for the licensed bands of the radio spectrum. The technical and organisational problems mainly involved a lack of trained technical personnel in the beginning of the project and lack of organisational experience for the project.

Box 1. Improved working conditions for researchers

The need for improved access to the Internet was obvious from the beginning. Even at the University of Ghana researchers wasted much time physically moving to a specific location for checking email and accessing the Internet. Only a few departments at the university had established direct access to the university Internet backbone. One researcher, who was heavily involved in the project, was from Department of Political Science, which had no connections to the university Internet backbone.

To provide hands-on experience with the WiFi technology, in the initial phase of the project, a wireless link was established between the Internet backbone and the Department of Political Science. This turned out to extend beyond a simple technical test and had far reaching implications for the department's teaching and research.

Soon after the establishment of the link, the department invested in a number of PCs, created a local area network and connected it to this link. ICT became a visible component within the department, of course dramatically reducing the time students and researchers used for accessing their emails and the Internet.

2.2 The IFLA and Danida Library Project

The objective of the technical task in the Library Network project was for the first phase to implement an Internet access to Balme Library and in the second phase to connect the participating libraries to the Internet via the Balme Library connection to the university network.

As the IFLA project was a trial, the intention was to investigate different technological solutions and implement some of them to obtain experience which could be used in other projects, both in Ghana and other countries.

The selection of Ghana and the involved libraries has been subsequently found to have been a quite good choice regarding the project's objective. The participating libraries have different characteristics regarding both their distance to the Balme Library and their level of telecom infrastructure development. In Table 1 the different libraries are described in the light of these two important characteristics. These different characteristics resulted in choosing different technological solutions for connecting the sites, described in the following section.

2.2.1 Implementation I: Connecting Balme Library to the Internet

This part of the project began towards the end of 1996 with a discussion of how plans for establishing the Internet connection to Balme Library could be coordinated with plans for implementing a backbone-ring as the beginning of a modern tele- and data-communication infrastructure for the University of Ghana at Legon.

In mid-1998, a connection was implemented between Balme Library's LAN and the university backbone-ring. The backbone-ring was connected to NCS, the local Internet service provider in Accra, via a radio link.

As depicted in Figure 6, the technological solution deployed to connect the Library Network to the backbone-ring was a simple one. Due to the short distance, the connection was implemented using optical fibre with Internet connectivity provided by a local ISP.

2.2.2 Implementation II: Connections between the libraries and the Balme Library

During the initial investigations there was a clear objective to find optimal technological solutions in view of the above-mentioned characteristics of the different sites. But there were some basic requirements to the solutions.

An important requirement was that the system be cheap (almost free when used). The Danida project, like other projects, had a limited duration and the system should be usable also after the project was finished, meaning that operation and maintenance costs should be as low as possible.

A second requirement was that the system be independent of the telephone infrastructure. This was because the system was also to be used in geographical areas where either no tele-

Table 1. Some characteristics of the participating libraries

Participating library	Distance to Balme Library	Telecom development
Tamale	Approx. 600 km very long distance	Bad telephone connections. Almost unusable regarding the objective (implementing data connection).
Kumasi	Approx. 300 km long distance	Good telephone connections but expensive to use because of rates for remote areas.
Cape Coast	Approx. 120 km distance is still considerable	Good telephone connections but expensive to use because of rates for remote areas.
Winneba	Approx. 60 km short distance	Good telephone connections but expensive to use because of rates for remote areas.
Korlebu	Approx. 13 km short distance	Good telephone connections and not so expensive to use because of local rates. But capacity is incomparable with the alternative solutions.
CSIR	Approx. 6 km short distance	Good telephone connections and not so expensive to use because of local rates. But the capacity is incomparable with the alternative solutions.

Figure 6. Balme Library connection to the Internet

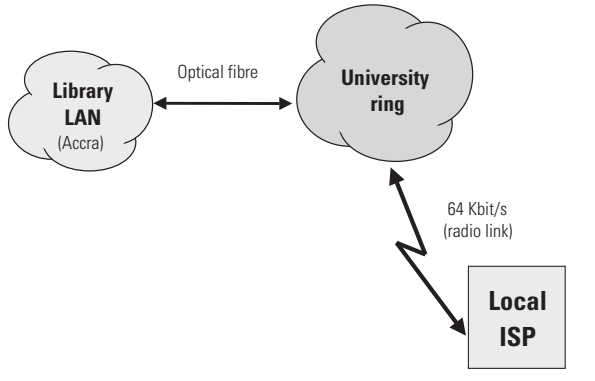


Table 2. Link Capacity

Participating library	Technical solution	Link Capacity
Tamale	HF	2.4 Kbit/s
Kumasi	HF	2.4 Kbit/s
Cape Coast	HF	2.4 Kbit/s
Winneba	VHF/UHF	33 Kbit/s
CSIR	Microwave	3 Mbit/s
Korlebu	Microwave	1 Mbit/s

phone network is available or the telephone network is of bad quality and/or expensive (see Table 1).

To meet these requirements it was necessary to base the solutions on wireless technologies and to use free frequency resources in the radio spectrum. From the beginning it was obvious that for long distances the establishment costs for implementing high speed solutions was too high to be realistic, for example, requiring many repeater stations to reach Tamale from Accra.

The results of the initial investigation showed that there were solutions that could reach remote sites without repeaters. These were based on the shortwave (HF) related technologies. The drawback of these solutions is that data capacity of the system is low. In spite of this drawback it was viewed as attractive mainly due to its cost profile and it was decided to try the system. In the end, however, this type of system was simply too expensive or in reality not available on the market.

This led to the formulation of a transition phase during which dial-up connections were implemented in all remote sites to begin Internet access and to promote results in the IFLA project. The high cost of system use was accepted as necessary to start the project. The dial-up connections were usable in all sites except for Tamale where phone quality was very bad.

The HF products were developed and delivered according to project specifications and were installed in two of the most remote sites – Tamale and Kumasi. Figure 7 illustrates the status of the Library Network during this phase. As it is shown, the local ISP was replaced by a VSAT connection directly to the Internet backbone (see below for further detail on the VSAT link).

The HF solution was also implemented in Cape Coast, whereas for Winneba, because of its relatively shorter distance, a VHF solution was used. For the sites that are closer to Legon, CSIR/Accra and Korlebu, a microwave (point-to-point) solution was deployed. The link capacities of these different technical solutions are outlined in Table 2.

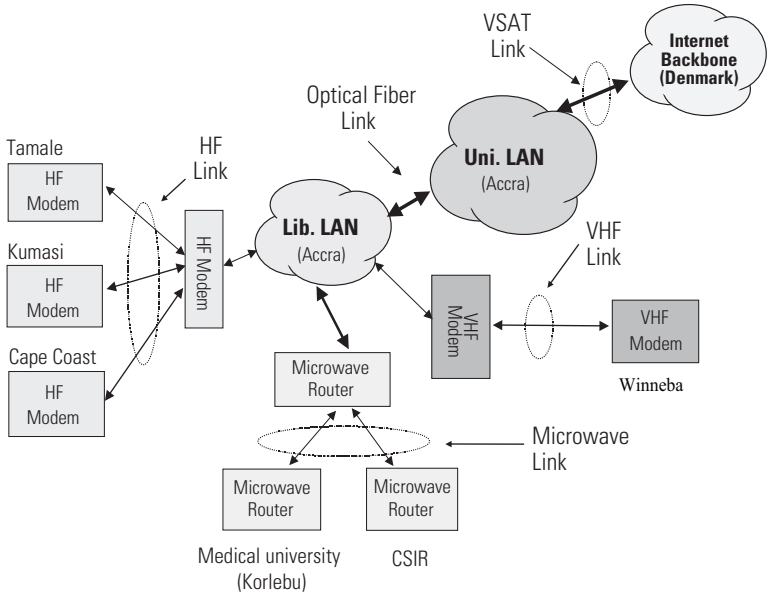
2.3 Research and Education Network

A major bottleneck for the IFLA/Danida Library Network was the slow Internet connection provided by the local ISP. Buying more capacity from the current provider was an option to increase the available capacity, but this solution was considered to be expensive and unreliable. Experience showed that the local ISP's system had frequent and long down-periods and further the delivered capacity often failed to match the promised capacity.

2.3.1 Technical implementation

Given these limitations in the established system, it was decided to implement a different solution using a satellite (VSAT) connection to link the research and education institutions in Ghana to an Internet connection point (in this case positioned in Denmark). This solution demanded a separate organisational structure (see below), had high start-up costs, but was cheaper for users. Moreover, the solution was 'future safe',

Figure 7. Library Network



being easily upgradeable. From a research and education perspective it was a more viable solution, because the university obtained control over the Internet connection to the outside world.

As depicted in Figure 8, the network was envisaged as consisting of different research and education institutions with the established university ring at the University of Ghana at Legon and the Library Network as associated networks.

Connection to other institutions in the Accra area, such as CSIR and Korlebu, was established via microwave point-to-point connections. The solution was immediately significant for institutions in and around Accra with a distance of about 20 to 30 kilometres from the University of Ghana at Legon. For institutions farther away needing a connection, different solutions had to be found, e.g., with the Library Network being associated with the solution, or using the fibre ring installed by the Volta Region power company in the southern region of Ghana. When the R&E Network was established the universities in Kumasi and Cape Coast were connected to the network via this fibre ring. Kumasi and Cape Coast both had a connection through the Library Network as described above and also through a fibre connection (illustrated in the figure). As the library connection was based on HF technology and was very low speed (compared to the fibre connection) there was little incentive to use it. There was, however, a crucial difference between the two solutions: the Library Network use was based on an almost free technology, whereas the cost of a fibre connection is very high.

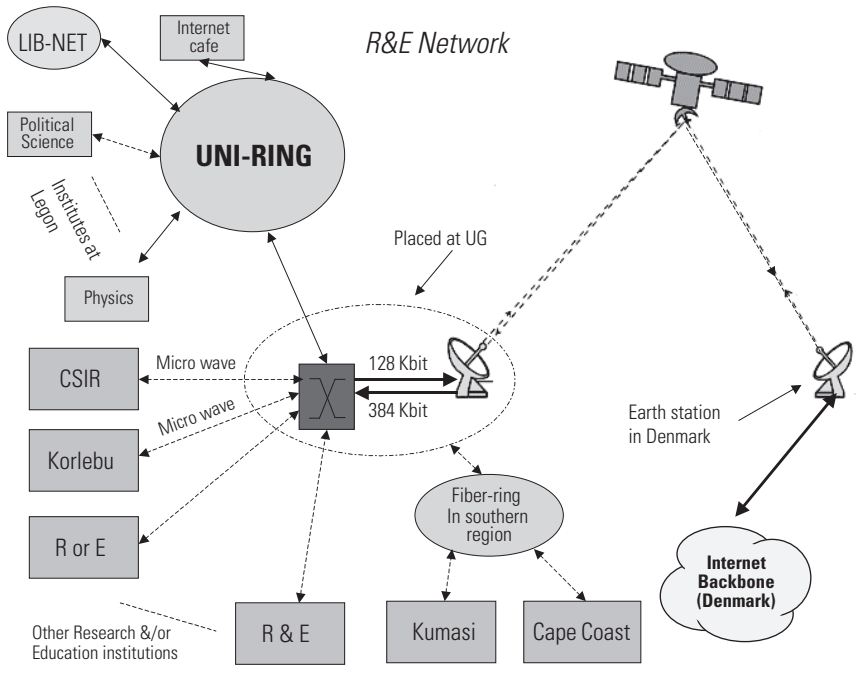
2.3.2 Organisation

A precondition for the projects was their ability to demonstrate long-term financial self-sustainability. The organisational aspect of this was addressed by establishing an independent organisational structure to ensure that different interests were addressed, the system was maintained properly, and that proper procedures were in place, e.g. for efficient and transparent cashing-in of contributions, etc. The structure was composed of three functions: a supervisory function, technical management and financial management.

The supervisory function was performed by the board of the network, which includes representatives from the participating institutions. The board should decide upon conditions for participation, price policy, etc. and supervise that the organisation was actually run in accordance with these conditions.

The technical management performed maintenance, expansion and upgrading of the system and *the financial management* took responsibility for financial functioning of the organisation including timely collection of contributions.

Figure 8. Research and Education Network



Box 2. Network performance and capacity needs

Although the VSAT and improved network infrastructure radically increased the capabilities of the network, from a user point of view it was difficult to see all these improvements. An investigation was undertaken to determine the reasons for this and it was concluded that they were partly due to problems in the daily organisation and use of the network.

The VSAT connection to Denmark worked properly. Regular measurements of the gateway router showed that the connection speed was high before and after working hours, indicating that the lower performance of the network during the day was due to congestion on the network. Analysis indicated that the likely reasons for congestion were basically:

1. An increased number of devices connected to the network during working hours. For example, at the beginning of the project there was only one PC connected to the network in the Balme Library. Soon after a computer lab with 25 Internet enabled PCs was established and during a two-to-three year period this number increased to 150 PCs, which were used intensively;
2. Some of the devices connected to the network generate noise traffic; and
3. The structure of the network was identified as inadequate, requiring redesign.

Based on the analysis some guidelines were devised for improving both capacity and security:

- All PCs connected to the network should have an anti-virus program installed;
- Any PC generating noise traffic should immediately be taken off the network;
- There should be control over the number of devices connected to the network;
- There should be control over how Internet services are used. There should be rules regarding limits to acceptability for using the network to access non-relevant materials and services;
- Mail servers should function properly so that users are not forced to use web-based mail applications such as Hotmail, Yahoo, etc.; and
- A firewall was identified as an important requirement for the network.

2.4 Challenges and lessons learned

2.4.1 Regulatory, technical and organisational barriers

The major regulatory barrier was the frequency assignment process for the licensed bands of the radio spectrum, i.e., HF and VHF. Microwave solutions are based on the WLAN, 2.4 GHz, which are accessible without any licence all over the world.

One of the reasons for the slow assignment process for getting HF and VHF licences was that the application we wanted to use was new. HF and VHF are mainly used for voice communication, either in the broadcast sector or in the communication sector like in the professional mobile radio sector. Using the spectrum to offer Internet connection to the remote universities was new and unknown. Another and more practical problem was that the formal users (the management of the University of Ghana and other universities) did not give the project high priority and did not allocate the necessary effort to put pressure on the frequency board. There were several reasons for this lack of enthusiasm on the user side. One of the main parameters was, however, that the HF-solution was seen as 'low-tech' compared to, e.g., a modern connection, and the users looked from the beginning for other solutions with higher capacity.

Another regulatory barrier was obtaining a licence to operate a VSAT connection. VSAT operations were only allowed to be undertaken by the incumbent telecom operator, Ghana Telecom, and the alternative general licensed tele-operator, WESTEL. This problem was quickly resolved by the University of Ghana's successfully arguing that the VSAT would be used for education and research purposes.

A specific technical problem was that introduced technologies were immature and therefore needed a relatively longer implementation time – especially the HF-solution that was developed for the project.

Lack of qualified staff was an overall challenge at the beginning of the project. This included both lack of trained technical personnel and the lack of organisational experience and it was addressed by intense training activity at different levels and by constructing an adequate organisation (see section 2.3.2).

2.4.2 Assessment of the deployed technologies

HF LINK

The HF link has very interesting characteristics. It is possible to establish connectivity over long distances without any repeaters. Compared to the other technology that also enables connection over long distances, especially satellite, it is much cheaper.

The link capacity is low (2.4 Kbit/s) but because there is (almost) no connection cost involved, it is a very good solution where other infrastructures do not exist, where cost is an essential parameter and the only other possibility is a satellite link.

To make HF work efficiently, the necessary frequencies must be assigned to the use. The characteristics of the HF fre-

quencies change through the day and night time. The equipment/use should be assigned several frequencies so it can shift between different frequencies and choose the best one.

The HF link has been the least appreciated link in the library project. From the beginning, the sites with HF connection looked at possibilities for establishing more modern connections and there was little willingness to adapt to the characteristics of this technology: the slow, but stable and very cheap connection. A related and self-fulfilling problem was the above mentioned slow frequency assignment process that implied that the solution was given 'test frequencies' that suffered from interference and resulted in occasional malfunction.

VHF link

Using VHF frequencies we established a link with a capacity of 33 kbit/s over a distance of about 60 kilometres. VHF was a cost efficient technology for this level of distance and the capacity was at an acceptable level, especially bearing in mind that connection to the Internet backbone for a long time was 384 kbit/s.

The link was used regularly, but suffered from long down-periods due a combination of power problems and lack of technical staff.

Microwave link

Microwave connections are truly high speed connections and they have been stable and very much used. Independent from the projects discussed here, other institutions have been connected to the network using this technology. The technology is a point-to-point WLAN connection using frequencies free for this type of use by international agreement thereby avoiding the process of specific frequency assignment.

VSAT

VSAT was a well-established technology and it has also in relation to our projects been a reliable connection to the Internet backbone. From the start of the REN project the connection was an asymmetrical 384/128 kbit per second connection and it was later upgraded to a 1 Mbit/512 kbit connection (and the technology platform was shifted from C-band to Ku-band).

3. Broader implications

We have not undertaken a comprehensive study to evaluate the full implications of the projects. However, smaller surveys and completely new library activities provide evidence that establishing Internet connectivity to the University of Ghana and the remote universities rather quickly changed study and work procedures. It has established a more modern platform for communication between researchers and given the students and researchers a powerful tool to gain information from the outside world. This must be seen in the context that the level of access to international research information was very low in Ghana – as in most developing countries – and access to the Internet radically changes this.

Indications for implications of Internet use as a communication and information medium include the following:

- The number of requests for articles grew and reached a significant level (the aim of the inter-lending activity of the IFLA-project).
- The use of PCs increased rather quickly after the introduction of Internet access – especially among students, but also among faculty.
- The number of PCs connected to the network rapidly increased both in terms of individual PCs and computer labs connected. The success implied that the system was overburdened and connections experienced by users as very slow. The growth in the number of connected PCs outpaced increases in connectivity capacity during the project period. This exposed a lack of efficiency at the organisational level.
- The network traffic was monitored and revealed full (over) use of the resources from early morning until midnight.
- Access to international scientific databases via a combination of CD-ROMs and Internet access radically altered the more general connection of students and teachers to the international academic community and gradually made inter-lending superfluous.

4. Conclusion and future perspectives

In this chapter the establishment of Internet access in Ghana and the creation of a Ghanaian Research and Education Network are described and the drivers, barriers and implications of the project are analysed.

A key finding is that even low cost projects can engender major changes in research and education environments in developing countries. A bottom-up approach to information society development is relevant. The introduction of modern, networked, electronic tools, even in environments with weak or nonexistent infrastructure and lack of human resources, has been illustrated as economically feasible. The Ghana case described in this chapter was initiated as a trial project. Funding for formal evaluation of to what extent the results and experiences from this case are applicable to other environments in other countries has not yet been provided, but a lot of positive implications have emerged – both directly for education and research and indirectly for new industry-university links. Some of the solutions are being transferred to other countries.

Regarding specific local access solutions, the performance of microwave especially, but also VHF connections, were appreciated by the users as adequate. The HF solution, compared to other technologies, has the advantage of end-to-end

connections between sites of 600 kilometres (and more) distances without any repeaters. The fundamental weakness is that it is a very slow connection, but it may be used to send email and also to browse Internet pages – especially if images and other fancy content are disabled. This leads to the general conclusion that the relevance of solutions for electronic communication is not only a technical issue. A given technology enables certain tasks. Whether these are relevant in a given environment are political and administrative issues. The HF solution in Ghana delivered Internet access to places without functioning telephony and was as such a major leap forward, but was rejected as too low-tech based not on its performance, but on technological prestige. This is illustrated in tems of the experience in which two of the sites were able to use the prestige argument as an incentive to fund more advanced solutions whereas a third site did not manage not and at the time of writing is still without any Internet access.

The VSAT solution has proven efficient for connection to the Internet backbone in places lacking fibre access, despite its cost. The relation between cost and capacity calls for an organisational solution in which several institutions go together, for example, as did the European Research and Educational Networks (RENs), a key strategy for development of ICT –with respect to both technology and usage. This was targeted with the construction of a Ghanaian REN involving key institutions. The organisational set-up proved too weak, however, to cater for all essential interests. Being based at the dominant academic institution, the others concluded that too little attention was paid to them. An important point here is that the REN itself was under-resourced and failed to convince the management of the universities of its importance – both to them and the national development of ICT.

The practical results illustrate that important short-term results are attainable if the overall information society policy is coordinated and connected with targeted bottom-up approaches. Further, to realise potential impact it is important that these connection are both acknowledged and appreciated.

Notes

[1] The work discussed in this chapter was organised across two projects, the Technology Assessment Project (TAP), sponsored by the Danish International Development Assistance Program (Danida); and the Interlibrary Lending and Document Delivery in Developing Countries project, sponsored by the International Federation of Library Associations and Institutions (IFLA) and Danida.

[2] See: <http://www.ashesi.org/GHANA>.

References

Aizu, Izumi (2002). A Comparative Study of Broadband in Asia: Deployment and Policy, *Asian Economic Integration-Current Status and Prospects*. Symposium hosted by Research Institute of Economy, Trade and Industry (RIETI). 22 April. http://www.rieti.go.jp/jp/events/02042201/aizu_1.pdf

Alemna, A.A. & Skouby, K.E. (1999). An Evaluation of Library Networks Among University Libraries in Ghana in the Light of the IFLA/ Danida Project. Accra: University of Ghana. June.

Henten, A. & Kristensen, T. (2000). Information Society Visions in the Nordic Countries, *Telematics and Informatic*. New York: Pergamon Press. Vol 17, No 1-2.

Henten, A., Skouby, K. E. & Morten Falch (1996). European Planning for an Information Society, *Telematics and Informatics*. New York: Pergamon Press. Vol 13, No 2-3, pp 177-190. March.

Selhofer, H. & Mayringer, H. (2001). Benchmarking the Information Society Development in European Countries, *Communications & Strategies*. No 43.

Wilskofsky Gruen Associates (2005). Telecommunications Market in Ghana: Status and Outlook, New York: Wilkofsky Gruen Associates.

Zhu, Haibo (2001). The Impact of the Industrialisation Policy on Telecommunications, the Deregulation Process and Foreign Financing: China's Case, *Communications & Strategies*. No 41.