WIRELESS TECHNOLOGIES AND DEVELOPMENT IN AFRICA[1]

By
Catherine Nyaki Adeya

2005

Table of Contents

1.   Introduction[2]

Advances in the area of wireless technologies have the potential of transforming communication initiatives especially, in the developing countries of Africa that are characterized by a dilapidated telecommunications infrastructure. Through these technologies, it is now possible to bring wireless access to remote and disadvantaged communities. It is also significant that costs for wireless technologies continue to drop, making wireless connectivity increasingly affordable. Today, many in Africa are plugged-in and switched-on (Zachary, 2004).

The most documented form of wireless use in Africa is the mobile phone. Growth in mobile telephony in Africa has been rapid in the last eight years, since telecommunications sector reforms in most countries opened markets to competition as a result of the 'Basic Telecommunication Services Agreement'. The demand has overtaken that of fixed line services. For most of the new subscribers, their mobile phone is their first and only telephone.   Most countries in Africa have at least two mobile networks, one of which is government-owned. By the end of 2001, Africa had 104 mobile networks operational, serving over 14 million customers in addition to 10 million in South Africa (Warnock and Sarkar, 2004), and they were almost 52 million by the end of 2003 (ITU, 2004). By far, the majority of the systems in use are now based on the digital GSM standard.

One notable observation is the considerable variation between different African countries' adoption and use of these technologies, ranging from the fairly advanced status of South Africa to the relatively under-developed status of Somalia. This paper has not dwelt much on South Africa, even though there is a lot of documented literature from this country, because it is not representative of the rest of the continent, especially sub-Saharan Africa where poverty is the norm. The developments in South Africa given their nature and scope would constitute a more comprehensive study.

Some examples from Africa show the surge in the mobile sector growth in Cameroon has, in a way, compensated for the disappointing performance of Cameroon Telecommunications Company (CAMTEL). The mobile phone accounts for more than 4 percent of teledensity and the fixed lines for less than 0.7 percent in the country which has a population of 16 million (Nzepa, 2004). In Ethiopia, the current demand for mobile lines is five times that of the fixed line waiting list. The number of subscribers improved in 2002 following the expansion of the network and introduction of the prepaid service (Adam, 2004).

In Kenya, the combined connections for the two cellular operators had increased from 15000 to 2.1 million by the end of 2003. This difference represents a growth rate of 27.8 percent per year (Mureithi, 2004) and is much higher than the 3.5 percent rate of the fixed line operator. There are currently 6.8 million subscribers as of June 2005. The mobile network is now over ten times the size of the fixed network in subscriber

---

[2] This is a working draft, please do not cite.

numbers. Figure 1 illustrates a comparative growth of the mobile and fixed line networks in Kenya.

COMPARATIVE GROWTH OF FIXED AND MOBILE NETWORKS AS AT 30TH JUNE OF EACH YEAR
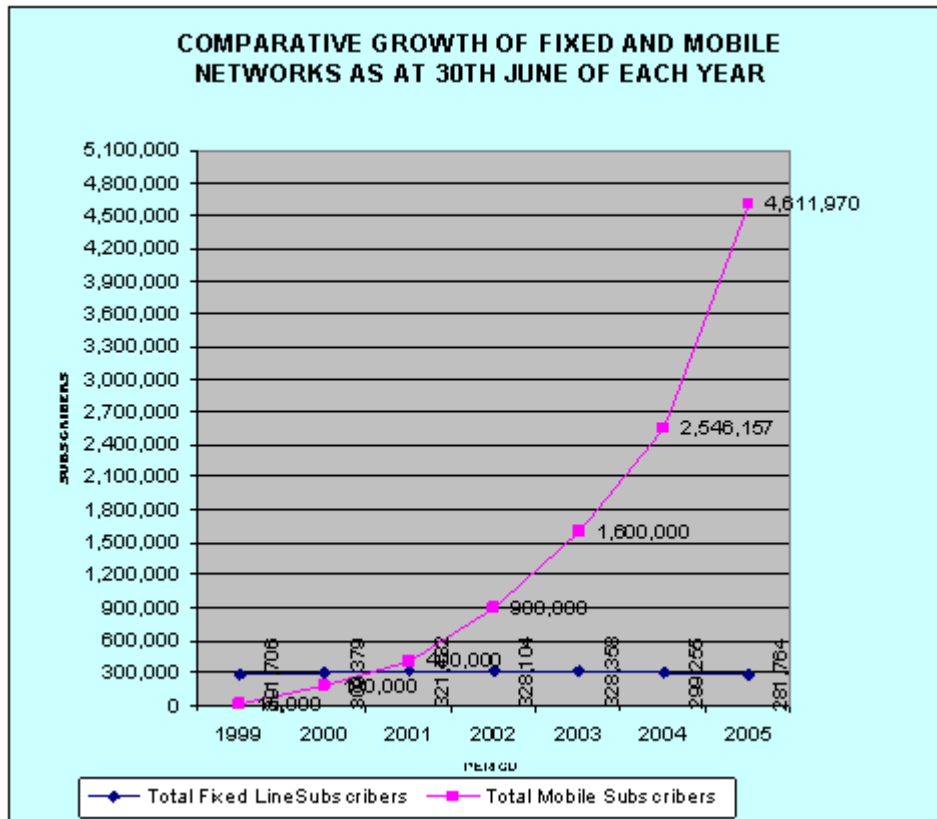
Figure 1[3]: Fixed and Mobile Networks Growth in Kenya [Source: Communications Commission of Kenya]

In essence, it reconfirms the changing consumer preference for cellular. In Uganda, mobile phone subscribers grew from 12,000 in 1998 to 711,313 in 2003. Conversely, fixed lines grew by 5 percent from 56,196 to 64,856 lines in the same period (Gamurorwa, 2004).

In view of the fact that mobile phones are the most visible form of wireless use in Africa, section two discusses the various ways in which mobile phones are deployed in Africa with a specific focus on network deployment, user-driven practices, and complementary services. Section three the applications of mobile phones for development in Africa. In the next section, attention shifts to literature on other forms of wireless technologies for development, specifically, 'non-mobile phones'. The last section is devoted to some concluding remarks.

---

3 http://www.cck.go.ke/market_information-telecommunications/

2. Methods of Mobile Phone Deployment in Africa

2.1 Network Deployment

Mobile phones have been deployed in various ways in Africa. The most popular is the prepaid system which includes pay-as-you-go, no need for credit checks, no need to track customers and resolution of the unpaid bills. The prepaid system also makes it possible for cash flow from informal economic activities to enter the formal accounting system, thus improving the calculation of economic indicators, such as, GDP (African Business, 2002).

By way of example, the growth in the mobile phone sector in Kenya has been attributed to the introduction of prepaid service and the flexibility in pricing through per second billing (Mureithi, 2004). The fundamental issue of consumer protection in the telecoms market cannot be underplayed. It is evident that the per second billing introduced by mobile operators in East Africa had demonstration effects in other African countries like Nigeria where consumer groups, analysts, civil society groups and phone users started pressurizing mobile operators to emulate their East African counterparts (Badaru, 2004). In Nigeria, most operators charged per minute, and there were other complaints of dropped calls, regular network congestion and undelivered but billed SMSes. It was the potential of competition – when Glo Mobile entered the market and introduced per second billing in late 2003 – that finally made the providers like MTN, Econet and MTel listen to the users and do the same. It would be interesting to analyze the impact of consumer groups and users in ensuring the mobile operators make their services more affordable.

In Kenya, like in many African countries, connection charges have reduced over the years from Ksh. 68,000 (US$ 907) in 1998 to as low as Ksh. 2500 (US$ 33). During promotions the connection charges drop to Ksh.99 (US$ 1.30). The mobile phone operators have introduced a range of tariff packages to suit different categories of users. The tariffs vary from as low as Ksh.8 (US$ 0.11) for mobile-to-mobile calls in CelTel, to Ksh.32 (US$ 0.43) for Safaricom. The volume of the SMS messages has in addition drastically increased from no SMS in March 1999 to 30 messages per month per customer by the end of 2003 while SMS costs have also reduced from Ksh.10 (US$ 0.13) in 2000 to the current Ksh.5 (US$ 0.06) (Mureithi, 2004). SMS is now widely used for business and social interaction. It is also evident that the availability of cheap handsets enhanced the growth of mobile telephony in Kenya. One can now purchase a handset for less than Ksh.3500 (US$ 47).

Although certain authors reiterate that mobile phones are expanding rapidly in the rural areas of Africa, others contend that this growth is limited to urban centers (Business in Africa, 2004). One factor hindering the uptake of GSM in Africa is the logistics involved in selling airtime to end-users. The traditional vouchers system presents mobile operations with a number of challenges including the physical distribution of the vouchers to remote areas, fraud, voucher shrinkage and the high commissions that need to be paid to the physical merchants who sell the vouchers.

Such challenges are not often apparent to mobile phone users and that is why Nigerians were disappointed at the high prices of the GSM systems of two South African based

companies, Econet and MTN. An official of the Bureau of Public Enterprises reportedly said the GSM system "was not really aimed at the common man" (Jason, 2001:39). Operators blame the high cost of doing business in Nigeria for the high prices. Contributing factors include:

- GSM license fees of US$285m compared to US$10m in South Africa;
- Higher cost of setting up a base station, and the cost of electricity – $104 vs. $12m in South Africa;
- Problems of interconnection between the two networks and also with the fixed line operator.

The answer to the disappointed Nigerians may partially be found in the recommendations of the feasibility study to investigate how to provide profitable low-cost telephony in rural regions of Africa; Tanzania was used as the pilot case (Engvall and Hesselmark, 2004). One of the main arguments in the study is that low tariffs and low cost of entry are essential for provision of rural telephony. The researchers note that mobile phone operations in developing countries are highly profitable, because they tend to focus on short-term investments in urban markets. They claim that telephony can therefore be provided in African countries at a much lower cost than is currently the case, (up to one-sixth of prevailing mobile rates), using a model that produces lower revenues but higher usage levels. In their assessment, despite the initial lower revenues, the network effects of increased user numbers lead to increased traffic. From a methodological perspective, the business model at the center of their study was based on the following premises:

- limited mobility services and designation of home zones (which would reduce the threat to national operators);
- local tariffs comparable to those for fixed lines;
- large proportion of revenues to be derived from incoming calls from high-income areas courtesy of interconnection fees;
- Operation of independent GSM networks by rural operators.

Results of their analysis indicated that GSM would be the most cost-effective technology for providing low-cost telephony to low-income areas and would require operating solely on a prepaid basis. However, preconditions would include clarifying licensing issues, as well as handsets equipped with the ability to provide notification of account balances, partially to facilitate sharing of handsets.

Their findings showed that country trends tend to move either to high or to low price categories. Therefore, it is unlikely that low cost operators would enter a market where prices are already high. This is because the prices will remain high until growth rates slow down enough to warrant price reductions. With their preference for rapid payback from investments, existing operators are also unlikely to be enthusiastic about providing low-cost telephony in rural areas. Engvall and Hesselmark (2004) suggest that to be viable, networks require a customer base of at least 20,000. These results have to be examined against the backdrop of high levels of usage in some African countries. For example, a study by Merrill Lynch reports that Nigerians use their mobile phones for 200 minutes per week compared to usage times of 154 minutes in France, 149 minutes in Japan, 120 minutes in Britain and 88 minutes in Germany (Hall, 2003).

Nevertheless, there are other innovative initiatives to deploy mobile phones to developing countries. The most often cited example is that of the 'Village Pay Phones' (VPPs) of the Grameen bank. It has drawn significant interest not only in the popular press, but also in research papers. Some notable works in this respect include Ahmed (1998), Bayes *et.al.* (1999), Camp&Anderson (1999), Lawson&Meyenn (2000), Telecommons Development Group (2000), and UNCTAD (2001). From its success in Asia, Grameen Technology Center decided to extend its Village Phone Program to Africa, specifically to Uganda in 2003. The program is run in collaboration with MTN Uganda as well as a number of local microfinance institutions. The involvement of multiple micro finance organizations makes it possible for the program to operate on a viable scale. In its first year, there were 1300 operators. About 100 new businesses are added every month and usage levels exceed initial projections by 25 per cent. Generally, the results have been positive – operators enjoy increased income, increased ability to cater for family needs, and expansion of their business networks (with most being engaged in other enterprises).

The Dot-ORG (2004) describes how village phones are used in Uganda for business transactions, communicating with family, calling radio shows, and checking prices of agricultural goods. Preliminary results show that the system is developing differently from that of the financier. In Uganda there are several local micro finance organizations involved in addition to Grameen. The different organizations offer loan terms ranging from 6-24 months unlike the Bangladesh case where there is a standard two-year loan term. Operators have a wide range of business expertise. In another study, Ulfelder (2002) describes how there is a similar program to Grameen's Village Phone system coordinated by CelTel Uganda, in collaboration with a micro finance company (FINCA). Local operators lease a mobile phone kit from CelTel and retail airtime to callers at US$0.28 for local calls and US$1.28 for international calls. They pay a monthly leasing fee to FINCA and airtime charges to CelTel. This program has been successful, with revenues growing at nearly twice (10 percent monthly on average) the rate of growth in mobile subscriptions. In 2004, MTN launched a similar concept in Rwanda known as Tuvugane[4] with 600 payphones but currently they have 19000**.** It is arguable that the success of these initiatives can largely be attributed to the telecommunications provider, MTN.

On the other hand in Kenya there is 'Simu ya Jamii'[5]; a community-based mobile telecommunication powered by the Adtel Adondo equipment and connected to the Safaricom Network. K-Rep bank, which specializes micro-finance and aims at serving low income people, gives loans to those who want to run a 'Simu ya Jamii'. The loan repayment period is up to 24 months[6] similar to that of the Uganda Village pay phone initiative. It is tailored to satisfy the communication needs of the poor especially those who do not have personal mobile phones. There is no need to purchase scratch cards[7] and billing is done per second. Interestingly, even those with mobile phones who sometimes cannot afford to buy airtime, use the service. This has to be understood in the context of the purchasing power of most Kenyans. The cheapest scratch card is Ksh.100 (US$ 1.3) and one can use the 'Simu ya Jamii' for Ksh. 20 (US$ 0.26) per

---

[4] "We can all talk".

[5] Direct translation from Kiswahili is 'Phone for the Community'. Other details available in http://www.safaricom.co.ke

[6] See Micro-Finance Network, June 2, 2005 Volume 1, Number 1 at
http://www.mfnetwork.org/files/MicroFinance%20Network%20Newsletter%20-%20Volume%201,%20Number%201.pdf

[7] 'Scratch cards' can be referred to interchangeably as 'airtime' or 'credit'.

minute during peak hours and Ksh. 16 (US$ 0.21) off-peak. The initiative has not only created jobs in low income areas but has given greater access to communication facilities for the poor. According to the Communications Commission of Kenya (CCK)[8] there were 5000 community payphones by the end of 2004. It is noteworthy that the other mobile service provider CelTel has a similar initiative called 'Simu Yetu'[9].

The other examples of how mobile phones are deployed include the use of bicycle phones and resale of minutes. Bicycle phones are being used in parts of Africa giving access to people wherever they are. In Kenya, the mobile phone provider Safaricom is supporting this initiative though it is not very widespread and is more popular in the urban areas. The public phones in the town centers are often vandalized or out of order, so the bicycle phone is filling in a much needed gap; though its usage is not yet widespread in East Africa and documentary evidence of how it is being deployed in other parts of Africa is scanty. Another way in which mobile phones are deployed is through resale of minutes. There is a suggestion that people can use their mobile phone credit to purchase goods in a shop. This is different from the sharing of minutes in which someone gives some of their airtime but no tangible goods are given in return. However, the concept of resale of minutes is yet to be proven. In their study in South Africa and Tanzania, Samuel *et. al.* (2005) found that a limited number of respondents made money from renting out their phone.

2.2 User-Driven Practices

Users in Africa have found ways to cope with the high prices of mobile telephony. Evidently lack of handsets in Africa has not hindered people from purchasing sim cards, sharing phones and using communal phones. Sharing sim cards is not uncommon in many parts of the world; it is just more visible in Africa because it is so widespread. From my experiential knowledge, in the urban areas it is mostly in the case where someone's or my battery is dead and there is no where to charge the phone. This mostly happens when we experience the common power outages which can occur the whole day or night, so it is not unusual for neighbors to share phones but not for small talk to minimize the battery. On the other hand in the rural areas sharing is mostly with those who have sim cards but are too poor to afford a phone. One of them told me it is better to have their own number rather than go all the way to town (which means transport costs) to make a call. In addition, it gives him a sense of identity despite his social status. I have observed that when these people borrow phones, they check for SMSes, reply to some, and then start 'flashing' others to call them. It is rare to see anyone in the rural areas who owns a sim card and no phone actually using their own credit to make a call.

An interesting example of phone sharing is a couple in Western Kenya who have their own sim cards but one phone. The wife has a CBO (Community Based Organization) which focuses on AIDS orphans so during the day her sim card is in the phone and after 6pm it is her husband's sim card. She explained that during the day she uses her line mostly for business and people know it largely for that purpose though occasionally it may be social. However, if one calls her after 6pm, it would largely be a social call because her husband's sim card doubles as their house telephone number.

---

[8] http://www.cck.go.ke
[9] This means 'our phone' in Kiswahili.

It would seem access to or use of mobile phones is now possible in Africa to those at all income levels. This is further confirmed in a study to ascertain the most important influences on the use of mobiles (Samuel *et.al.*, 2005). One was income, which they were not able to exhaustively analyze for Tanzania because of the low income of the Tanzanian communities in their survey. In this regard, they observed the tendency in these communities to rely on subsistence farming instead of cash income. In comparison, their analysis of the influence of income for South Africa generally showed a positive relationship between mobile phone usage and income. They found that people at all income levels are able to access mobile services, either through owning or through sharing a phone. Significantly, gender, age and education do not seem to constitute barriers to access.

Respondents in the lowest income bracket tended to be frequent users of mobile phones by discovering clever ways of minimizing their own call costs. One example cited is 'beeping' (also known as 'flashing'), through which a caller dials a number, but hangs up before the call is connected to elicit a call back response from the recipient. In this way, users in the low income bracket are able to avoid expenses on call charges. More sophisticated survival versions for these users include assigning meanings to specific numbers of rings. For example, three rings might signal the message 'I am leaving now' (Samuel *et.al.,* 2005). In Funyula, a rural part of Kenya, one of the public phone operators charges customers about US 2 cents to 'flash' because receiving a call is free though they are not allowed to engage the phone for long. In most African countries people only pay to call and not to receive like is the case for some mobile service providers in the USA.

This can be very irritating to some users but Safaricom of Kenya and some other mobile service providers have found a way around this. Recently, in August 2005, Safaricom introduced a service called 'Flashback 130' with adverts that *"Stop Flashing! Ask Nicely, use FlashBack 130"*. It is very simple and is free; a polite way for one to ask for someone to call back when one lacks credit or is in distress. Each person can send up to five free messages a day by sending a message to *130* with the number of the subscriber to be prompted and they will receive a message "Please call me back, thank you." It is too early to assess the impact of the service but it has proved to be very popular.

This shows that people will come up with all mechanisms to communicate at the least cost. Furthermore, the ingenuity of some Africans to make sure they have access to communications cannot be underrated. In Ghana some build towers out of wood and stone on hilltops ('cell phone towers') and charge callers to climb to the top of the tower to access mobile phone signals that are blocked by the hill. This is more convenient for some people than having to travel to a place where there is signal (Hall, 2003). A similar story comes from Congo where according to Gilbert Nkuli[10] of the Vodacom group, enterprising villagers are so eager for mobile phone service that they have built 50-foot-high tree houses to catch signals from distant cell phone towers. In fact one man uses it as a public pay phone because those who want to climb to his platform and use his phone pay him for the privilege.

In the deployment of mobile phones some have tried to examine the difference between business and personal use. Samuel *et.al.* (2005) present the results of research into the

[10] 'Africa Fastest-Growing Market for Cell Phones' [http://www.wins-news.com/top_stories/2005/aug/082505-e.php]

socio-economic impacts of mobile communications on households, rural communities and small businesses in Africa. Relevant data came from face-to-face interviews that they conducted in South Africa, Tanzania and Egypt. In Tanzania, 34 percent (of 223 respondents) used mobile phones to access business information. For example, in Mafia Island (Tanzania) the proprietor of a small fuel supplies operation used his mobile phone to place orders for more stocks of fuel and to confirm the date of shipment from the mainland. He said he is now able to source fuel from more suppliers than before because of his mobile phone.

Samuel *et.al.*, (2005) also examined how mobile phones were used by small businesses in South Africa (urban and rural) and Egypt (Cairo only). Evidently, this was not a comparative study, but a reflection of usage patterns because the environments that were selected are very different. Nearly 85 percent of the businesses in the Egyptian sample and 89 percent of the businesses in the South African one used a mobile phone, compared to figures of 11 percent and 34 percent respectively for the two countries five years earlier. Over the past five years, therefore, the number of businesses using mobile phones increased by over 547 percent in Egypt and nearly 125 percent in South Africa. These percentages are significant given that the percentage increase for fixed line telephones in the two countries over the same period stand at only 71 percent and 15 percent respectively.

In South Africa, there was evidence that mobile phones were the only source of communication for a large number of small businesses especially in the rural areas. Hypothetically this would be the finding in most parts of Africa; if businesses in the rural areas have one phone, it will be a mobile phone. Samuel *et. al.* (2005) advance the thesis that little is known about how rural communities and small businesses use mobile telephones, and what impacts they are having. It is a fact that there is very little empirical information on the impacts of mobile phone use in rural communities or by small businesses in Africa; but it is common to find a lot of information on the potential of mobile phones for small businesses.

In a similar example, Rydhagen and Trojer (2005) reiterate the social and business benefit of mobile phones. The authors give the example of an interview they conducted in September 2003 with a 55-year-old poor Tanzanian woman. The interviewee said her family could not afford a fixed line telephone, but they bought a used handset with a prepaid service provision. This made it possible for her to develop her businesses, as a necessary complement to her meager teacher's salary. The interviewee preferred the prepaid service because it enabled her to plan and avoid the inflated monthly bills from the fixed line operator[11]. Another illustration is of an illiterate woman living near the Congo whose customers phone her when they need fresh fish. According to Nkuli[12] of Vodacom, "she doesn't have electricity; she can't put the fish in the freezer." Therefore, she keeps them in the river, tethered live on a string, until she receives a call; then she retrieves them for sale. These examples are similar to the concerns shared above in the anecdotes by those in Kenya sharing sim cards and using 'Simu ya Jamii'.

Research on the social role of ICTs has so far been heavily biased towards the Internet. Social capital might be a useful way of understanding the social role of mobile phones.

---

[11] In neighbouring Kenya, Telkom Kenya was forced to introduce prepaid cards for fixed lines because of the increasing competition from mobile telephones with a prepaid service provision, which though expensive are more popular.
[12] 'Africa Fastest-Growing Market for Cell Phones' [http://www.wins-news.com/top_stories/2005/aug/082505-e.php]

Goodman (2005:53) defines social capital as "the intangible value of the social group, on whatever scale, above and beyond the value of its individual members alone. It can be thought of generally as the social resources available for human activity". Mobile phones are used to mediate contact between different people, and so are likely to have an effect on the size, number and nature of social networks in which people participate. This in turn may affect levels of trust. Goodman's research aimed to use the concept of social capital as a framework for understanding the social impacts of mobile phones by theoretically connecting the localized social impacts to wider socio-economic changes. Consequently, the community questionnaires used in the surveys in South Africa and Tanzania included questions on different aspects of social capital such as social networks, group participation and social attitudes.

An objective of the research was to assess the importance of mobile phones compared to other communication means. Respondents in South Africa and Tanzania gave similar answers, which included frequent face-to-face communication with family, close friends and others within the community. There was little face-to-face contact with those outside the community. When asked if they had made a call or sent an SMS about business and education opportunities outside the community, the responses indicated that mobile phones are used to manage weak links. Evidently, if mobile phones were used to manage strong links, they would replace face-to-face communication which was not the case in South Africa or Tanzania, where face-to-face communication only reduced with those living outside the community (Goodman, 2005). The author suggests that further research could entail an investigation of this relationship, as many past studies suggest that communication over phones supplements face-to-face communication.

In addition mobile phones were being used to mediate both strong links (family and close friends) that are essential for maintaining support networks, and weak links (businessmen, tradesmen and government officials) to provide access to information and possible social and economic opportunities. Weak links are seen as particularly important in the relationship between social capital and desirable macro-level outcomes, and even more so perhaps in the Africa context, where communities can be very tight knit given their paucity of connections to the outside world (Goodman, 2005). Donner's (2005) article which includes use of mobile telephones by micro entrepreneurs in Rwanda confirms this. The results show that mobile telephony is important to small businesses; it expands business networks and amplifies social relationships. This can be confirmed in the case of Theuri and his 'Simu ya Jamii' discussed below (Obulustsa, 2005) and there are similar anecdotal examples all over Africa. Goodman (2005) concludes that within the parameters of the two surveys, mobile phones were facilitating participation in social networks, helping to maintain both strong and weak links, including participation in community groups. They were thus enabling people to invest in and draw on social capital.

Ascribing usage to the subscription of mobile phones in Africa is not representative of the reality. The penetration of the mobile service in many African countries is not easy to measure because of the practice of sharing phones. The truth is mobile phones, and their applications, are shared in many innovative ways in Africa. Thus, as an example in a household of six, all members tend to have access to the same phone, but the statistics given by the provider indicate only one subscriber to the service (Munsaka, 2004). This illustrates the necessity of having new parameters for measuring levels of mobile phone access.

There are strong network effects related to phone subscription. A network effect (or externality) occurs because each existing subscriber benefits when the total number of subscribers increases. As the total number of subscribers increases, so does the value of having a phone, because each individual can contact more people. The network effect is well understood in developed markets where personal ownership of a phone is the common model. However, the operation of network effects will be different where mobile phones are shared, for example, in a communal facility, such as, a 'Simu ya Jamii'. In a model of shared use, two-way communication is more difficult since a non-owning user can make calls out, but cannot receive spontaneous inbound calls (Samuel *et.al.*, 2005). For example, in the 'Simu ya Jamii' concept, although users can ask one to call them back, it is not encouraged unless one knows the owner very well but this kind of call is expected not spontaneous.

The concept of sharing is evident from a number of authors. Some attribute this practice to cultural factors. In this regard, it is argued that cultural factors influence whether mobile phones or fixed phones are preferred. Cultural factors also influence the propensity to share mobile phones in a community. Moreover, in some African countries, although a mobile phone may actually belong to a person, it is regarded as the property of the community, because of the culture of sharing. As an example, in Senegal villagers keep in touch with relatives in the cities or abroad by using shared mobile phones (Lopez, 2000); however this is widespread in Africa. Furthermore, children whose parents own mobiles often run to neighbors to inform them that someone would be calling back. These calls are normally spontaneous, one simply gives a neighbor's number even without informing them and this is accepted. The individualism in ownership exhibited in the West would be detrimental in Africa. If people do not share, the social benefits of mobile phones would have been much lower at the current penetration rates levels (Dholakia, 2002).

Anthony Zwane, a sociologist with the University of Swaziland points out nevertheless that mobile phones have become so ubiquitous in Southern Africa that non-ownership is becoming an indication of status among the wealthier public (Hall, 2003). The author views that in other African countries, the mobile phone is still considered a status symbol. This influences the way it is used. For example, in Rwanda people rarely share mobile phones but in Mali the "single-owner-multi-user" phenomenon exists. Zwane also advances the thesis that the mobile phone has reinforced the traditional oral culture in African communities.

Some of these attributes of sharing have an impact of usage. The Kenya mobile service provider Safaricom has capitalized on this. They introduced 'Sambaza' which basically denotes 'sharing'; in fact the advert is a cake that has been sliced up into many pieces. It is an airtime sharing service that enables prepaid subscribers to share airtime with their family and friends. Customers can send any amount from Ksh. 50 which is useful because the scratch cards are available in denominations of Ksh. 100, 250, 500 and so on. With 'Sambaza', for example, one can buy airtime of Ksh. 500, share with his wife for 150, children for 55 and 62; therefore access has been made easier and more affordable for everyone.

As popular as this may seem, there are already stories of misuse. My friend meant to send airtime to her sister in a different town but accidentally sent it to the wrong number. She sent an SMS to the person requesting them to send it back but they ignored. I have

had a similar experience when a stranger sent airtime to my phone then sent an SMS requesting me to return it, as it was meant for their mother, or to forward it to her number. Evidently what is needed is a service whereby one can be asked to reconfirm the number they wanted to 'sambaza' before the SMS is finally sent. Some people have voiced concern that these days when they 'share' their phone for someone "to send a quick message"; someone could also share their airtime without their knowledge[13]. This is also common in an office atmosphere where one can leave their phone charging on the desk. According to the CEO of Safaricom there are plans to enhance security features to avert possible misuse by a third party, probably through the introduction of an optional PIN number-based security feature, but this has not averted the popularity of the service.

2.3 Complementary Services

Mobile phones have been used for other services, such as, banking. ITU (2004:11) notes that in Zambia, mobile operator CelTel launched a mobile payment system CelPay and observes that this "type of application could have a major impact in Africa where much of the continent is 'unbanked' and (where) few possess credit cards". Account holders can make payments via SMS with a code identifying the payee. About 2000 subscribers make use of the service that CelTel hopes to introduce in other countries where it operates. The only limitation in the use of the mobile phones for commercial transactions in the country is a deal between banks and mobile service operators. In this respect, for one to access commercial transactions, one has to use a bank partnered operator. This condition encourages elitism, instead of responding to the interests of all (Munsaka, 2004).

The initiative described by the ITU (2004) and Munasaka (2004) appears similar to the MoPay system in South Africa. This is an SMS based mobile payment system for businesses. They can use it to settle accounts from customers. A supplier sends an SMS to a business owner with details of the payment required. He will select the amount, date payment is to be processed and activate the transaction using his pin number and the business owner's assigned MoPay number. Once the MoPay service has authenticated the identity of the parties and authorized the payment, both parties get confirmation messages. To subscribe, one has to pay R200 for registration and R200 monthly. Figure 2 is an illustration of the MoPay system:

---

[13] This concern was raised in a consumer watch forum and responded to by the Safaricom CEO M. Joseph. It can be found under 'Safaricom Boss on Sambaza service' at Sunday Standard, June 15 2005 at
http://www.eastandard.net/archives/sunday/print/news.php?articleid=22819

Figure 2 [Source: http://www.mopay.co.za/]

A similar program from South Africa is the Fundamo[14]; a system to make payments from mobile phones. The entrepreneurs behind this program tried to market it in the developed world but it was not popular because of its similarity with the credit/debit card

---

[14] http://www.fundamo.co.za/fundamo/index.html

system which is common in the West. The potential buyer keys in the details of the vendor they want to purchase from, the item and confirms the sale with a PIN number. The system then verifies with the buyer's bank and sends a confirmation to both parties. It has taken off in Zambia and there are clients in Kenya, Botswana and the Democratic Republic of the Congo; however the impact of this initiative has not really been evaluated.

Mobile banking has taken off in some African countries, such as Kenya and Nigeria, where users can send SMS to check account balances, transfer funds and carry out other transactions. The Co-operative Bank of Kenya became the first bank to launch basic SMS mobile banking services. Customers can subscriber to get automatic alerts when the bank receives their salaries, request a mini-statement, check account balance, pay utility bills and top up their mobile phone credit. The bank charges Ksh. 30 (US$0.20) per transaction. In Morocco, some banks provide real-time SMS alerts to inform customers when credit transfers are made. In July 2000, the first WAP[15] system in Africa was launched by CelTel in Congo, where online currency conversion was an instant hit with traders; an interesting initiative but there is no evidence that this is widespread in Africa. Apart from lack of awareness, WAP take-up has been slow on the continent outside of South Africa due to slow speed, lack of content and shortage of WAP-enabled handsets (ITU, 2004).

Mobile phones are also helping to achieve some of the universal access goals. Cases have emerged of how mobile phones can help overcome some physical challenges. In this connection, there is the example of a manufacturer of children's dolls in Cape Town who has deaf employees. Text messaging via mobile phones enables the owner and employees to communicate with each other. In the absence of this communication, the owner would not have employed the deaf people (Samuel *et.al.*, 2005). 'Simu ya Jamii' has given access to communication to groups – such as wheelchair users – that are not well catered for in other public phone access points. There is a specially designed 'Simu ya Jamii' for those on wheelchairs (though able bodied people use it as well), and mostly run by one of their own. It is much wider than the normal 'Simu ya Jamii' design, so it can fit a wheelchair, and the shelves are lower. If one has capital they can even have a 'kiosk' to sell other products.

There is a woman who was in the Nairobi Spinal Injury hospital for months after a serious road accident. She is widow with young children, now resigned to a wheel chair and cannot return to her job. She can no longer afford to rent a house in Nairobi so moved back to the rural area and started running a 'Simu ya Jamii', her only source of income. She is now able to continue feeding her family while providing access to communication to people near her rural home in Siaya, Kenya. There are fifteen other disabled people who are now sole bread winners in their families using 'Simu ya Jamii' based in their rural homes, such as, Bungoma, Meru and Eldama Ravine in Kenya. This is significant in a country where there is no system of caring for those who have disabilities; a situation that is not unique to Kenya. In fact, this was initiated through a pilot project entitled "Community Telephone Business for Paraplegics of the Kenyan Paraplegic Organization (KPO)[16] sponsored by the Safaricom Foundation and anecdotal evidence suggests it is successful and needs to be replicated.

---

[15] Internet access using the mobile phone as a browser is supported through Wireless Application Protocol (WAP).

[16] http://www.kenyanparaplegic.org/html/kpowinner.asp?pcat=&cat=projects&sid=28

In contrast, it is not uncommon to find that many owners of 'Simu ya Jamii' or other types of village payphones, are already entrenched in other businesses or formal employment. For example, Theuri (a Kenyan plumber and electrician) has a 'Simu ya Jamii' outside his shop which he uses to take orders and call around for supplies instead of traveling and wasting time like he had done previously. He has his personal mobile phone which he uses mostly to receive calls from potential clients and socially, so that he does not engage the public phone. It is cheaper to call from the latter and costs nothing to receive calls. Other business people in the vicinity also use this service when they have to make a quick call and do not have enough credit on their phones. It only costs Ksh. 20 per minute, cheaper than buying a scratch card (Obulustsa, 2005). Theuri confirmed that he had seen a marked improvement in his business, more efficiency and profitability, less time wasting.

The absence of electricity has not been a major barrier to access and use of mobile phones. For example, the popularity of 'Simu ya Jamii' has increased because it can be used even where there is no electricity; charging can be done using solar or car batteries. In Samuel *et. al.*'s (2005) study they found that users recharge batteries at the nearest town or locally using a car battery or generator. Even most operators in the Village Phone project in Uganda use car batteries to power their wireless phones. From anecdotal evidence use of car batteries is widespread especially in the rural areas of Africa and in the poorer sections of urban areas like the slums. I have observed in a local village shop where people charge their phones using car batteries or electricity from a generator when it has petrol. They are charged Ksh. 30 (US$0.40) for a full battery and half the price for half battery, basically the aim is to make it affordable. This is the nearest place for many people who want to walk and save on transport charges going into the town centre; they only go there when they have other businesses to transact.

In the town centre (Siaya town) there is one phone shop that sells airtime and phones. This is where many people also charge their phones. Many have to wait for their phones because there have been incidents of phones disappearing, and there are no guarantees or insurances; it is at their own risk after all it only costs Ksh.30 to charge. It is not like in South Africa where there are charging booths and one can lock up their phone and retrieve it later. It is common to find mostly professionals, like teachers, chatting near the shop as they wait because their schools do not have electricity; new social networks develop from this; discussions range from sharing expertise, development issues to politics.

Another example is at my parent's home in Ting'wangi village (Nyanza Province), one of the few with electricity. I have observed a few people who come specifically to charge their phones, mostly retirees who do not want to walk to the village shop, maybe to save their money and airtime[17]. They are not charged for this but I have seen them discuss issues from their experience, with those in the vicinity and others working in the compound like veterinarians and children. From a cultural aspect, it reminds me of how the old used to sit around the fire with the young and impart knowledge. This culture has gradually died in many communities but maybe this charging of mobile phones may partially replace it because it will be a long time before many of these people are able to

---

[17] It is common to find that these people may have the only phone in a small village and it is everyone's link for calling family in towns incase of an emergency or to receive calls from loved ones. They are sometimes referred to as the 'phone man' by children.

afford to connect electricity even with the numerous rural electrification projects in place. In retrospect, maybe it is also a way for these people to socialize because many retire to the rural areas and do not have anything productive to do.

The huge market for used handsets has made mobile phones more accessible even to those in the low income bracket; it is one step closer to the universal access goals. Increasingly more people are able to purchase phones/handsets even those which are used. In South Africa for example, used handsets are available for US$50 or less, an amount within the reach of many. They are even cheaper (minimum of about US$20) in parts or sub-Saharan Africa where there is now a huge market for used handsets. Many are even willing to buy those with dead batteries that have to be constantly plugged-in; they use these in their business (mostly small businesses) premises and at home. This is partially attributed to the lengthy waiting period for fixed lines. The flipside is the growing black market for these handsets may have increased theft. Though there is no clear evidence it is difficult to explain the mushrooming businesses for used handsets all over Africa and the increasing theft of handsets.

There is a hypothesis in Kenya that stolen phones are sold in Uganda and Tanzania. Those stolen in Uganda are sold in the other East African countries and the cycle continues. However, mobile operators in Tanzania, Kenya and Uganda signed a Memorandum of Understanding (MOU) to fight handset theft. They have all activated their Equipment Identification Registers (EIR), a system that blocks out a stolen handset once it is reported to the customer care. The only limitation is that users need to know the serial number[18], unique to each handset from the manufacturers, to enable the GSM network activate the EIR blacklisting; many people are ignorant of this until their phone is stolen. Badaru (2004) writes with concern about the growing theft of mobile phones in Nigeria that is costing many people their lives yet the mobile service providers have not been willing to do anything about it like those in East Africa have done.

Another cautionary example is from the experience of a hairdresser in a local market in Nairobi. She bought a used handset to be able to communicate with her clients. Unfortunately, everything was in German and there was no manual available. When she took it for assessment, she was told that it is not a language issue and not much could be changed. So she returned it back to the seller who gave her a lower price so that she can use it to call and receive, rather than for SMS and other applications. This is not an isolated case and the purchase of used handsets means one may have to forfeit some of the benefits of the phone.

3.   Applications of Mobile Phones for Development

The following are some examples of applications of mobile phones for development in Africa. SMS has proved to be a very popular application of mobile phones in Africa except in countries like Ethiopia where usage is low but this has been attributed to lack of support for the fonts of the official language (Amharic) and high illiteracy (Adam, 2004). Mobiles phones have been used generally to search for jobs and specifically in health and agriculture which are both critical areas of concern in Africa's development efforts. These uses are not exhaustive.

---

[18] This is also known as the International Mobile Equipment Identity (IMEI) number.

The impact of using mobile phones varies depending on social, employment and business considerations. Samuel *et.al.* (2005) found that there was more communication with family and friends, reduced travel costs and access to assistance in job searches. Field observations confirmed that mobile phones were essential for job search, for information and applications and for the contact method to be used by potential employers. The unemployment rate in many African countries is escalating. The challenge is some do not even know where to seek for jobs especially low skilled jobs that are too expensive to advertise in mainstream media.

An excellent initiative around this is the Open Knowledge Network's 'OKNBOP' which targets those seeking casual jobs through the *KaziSMS* at Ksh. 3 (US$ 0.04) per message. At present, the *KaziSMS*[19] service is operational under the umbrella of *Kazi560*. It allows one to send a message to the number 560 for a particular job through a text such as 'Driver ON to 560'. The service also allows employers to advertise job openings for free. Recently a major taxi company in Nairobi wanted 10 new drivers and contacted Oneworld. Within a few hours, they received several phone calls and quickly filled up the vacancies (Otieno, 2005). Most of the jobs require minimal education and skills. In the first seven months since the launch of Kazi560, a significant number of people been employed through the service that advertised over 150 vacancies per week in June 2005. Many have heard about it through the popular radio FM stations.

3.1 Health

The use of SMS is also being popularized in the health sector with some positive results. The Open Knowledge Network (OKN) has a number of pilot projects to deliver vital information to marginalized and poor communities in Kenya. The initial phase took place in Kibera, home to one of the biggest slums in East Africa. The main objective of the project is to use SMS to send messages on HIV/AIDS prevention and control; provide tips to pregnant women; offer health management and nutritional advice. The subscribers are charged Ksh. 7 (US$ 0.09) for each message (OKN, 2005).

There are other information services run by Oneworld in Kenya, such as, Health560, MyQuestion and Her560 (Otieno, 2005). Health560 is designed to help subscribers with useful tips on HIV/AIDS and breast cancer for a nominal fee of Ksh. 7 (US$ 0.09). They plan to introduce additional channels on diabetes, stress, drugs and baby care information which are all critical issues in the country but there is a lot of ignorance in these poor areas. A good example of impact is a lady in Kibera who received a tip on symptoms of breast cancer and realized she probably had cancer. She was able to seek medical attention for a situation that was manageable. MyQuestion is a SMS2Email based service that allows people to anonymously ask HIV/AIDS related questions and receive answers. The SMS is received by OKN as an email and a Knowledge Worker researches the question, backed by professional support provided by UNICEF and Nazareth Hospital in Nairobi. A response is then sent back.

A free service is planned for community news in Kenya starting with a pilot project at Kibera. It will target a controlled group of 1000 Kibera residents through a Bulk SMS

---

[19] 'Kazi' is the Kiswahili word for 'Work'.

Push service. This model has been used successfully in India. The group will share phones and extend service coverage to at least 5,000 direct users. The service will focus on health and business tips; public service announcements for instance lost children and security alerts; and possibly, messages (*Raila Says*) from their dynamic Member of Parliament, Raila Odinga (OKN, 2005).

Another example of innovative use of wireless technologies for health is from Bridges.org[20] (2003). The example is on an in-depth investigation of a pilot project by the Cape Town Health Directorate that tested innovative uses of mobile phones to improve the treatment of Tuberculosis (TB) in its clinics. South Africa has one of the most alarming TB epidemics in the world. The most recommended method for treating TB is the Directly Observed Therapy System (DOTS), where health workers watch patients take their medication each day; but this is difficult in a country where TB is prevalent and where the health workers are already overstretched. In this context, if patients miss an intake, they have to start the whole process again. Fortunately, the technology solution was provided by On Cue, a small company offering a Compliance Service that sends SMS to patients to remind them to take their medication at pre-determined times. The criteria for selecting the patients in the pilot study included ownership of mobile phones and the identification of those likely to take medication without supervision.

The study showed that the Compliance Service is a suitable adjunct to DOTS. It is also cost-effective for the health service and the patient, but there were some limitations on the effective use of the service, concerning mostly poor administrative procedures. In this regard, some patients did not use the service as instructed and there was no one on-site responsible for the project at the clinic level. Due to this oversight, some staff were lax and focused mainly on their formal clinic schedules. There were also issues of privacy, data protection and security that threaten the widespread use of the technological application in healthcare. Despite these reservations, the patients enrolled in the service and showed rates for TB cure and completion similar to those using clinic-based DOTS. Even the project managers confirm that these results should not be taken as representative due to the limitations. The lessons from the pilot project are useful in Africa where there are limited resources and where there should be improvement rather than replication of projects that are not wholly successful. Over the long term, innovative technology uses like this are likely to play a critical role in the rollout of treatment for HIV/AIDS and other diseases in the developing world. After revision the project should be rolled out in other environments.

Green (2003) and ITU (2004) also refer to the South Africa TB project. The former discusses the Cape Town based project in more detail and indicates it began as the innovative idea of a Cape Town doctor, David Green who introduced the concept of sending an SMS to patients to remind them to take their medicines. He named this system Cell Phone Prompted Self Administered Therapy (PSAT) and hypothesized that through it, staff would have more time to focus on patients who are poorly compliant. The World Health Organization (WHO) confirmed that the scheme is an example of best practice, since it had only five failures out of 300 patients involved in the pilot study. Moreover, it had succeeded in addressing a real need in an affordable and simple manner. Wright (2004) also discusses the same TB project in South Africa and notes that hospitals in South Africa are beginning to adopt WLANs with the first completely wireless hospital in Africa being the Ikosi Albert Luthuli Central Hospital in the country. In

---

[20] http://www.bridges.org/

the hospital, doctors use laptops to access patient information from a centralized records system. Hand-held and wireless applications are certainly useful in healthcare provision as the South Africa experience illustrates. However, they are not an end in themselves but will complement PCs and other emerging technologies (Darby, 2004).

3.2 Agriculture

The agricultural sector is significant in most African countries. A notable project on the relationship between wireless technologies and agriculture is DrumNet, the Pride Africa project. It offers support services to smallholder farmers who too often operate their businesses without access to information, financial services or markets. Launched in 2002, the project has been designed to bridge this gap through ICTs, efficient business processes and economies of scale. For a small fee, DrumNet provides marketing and financial services for agricultural entrepreneurs (Grogh, 2002). The pilot phase is currently operating in Kirinyaga and Nairobi in Kenya, but it is envisaged that DrumNet will grow to become a broad network of information access points for agricultural producers throughout East Africa. In cases where credit is available, farmers have still been unable to utilize it to the maximum because they lack key information or timely access to the market. Due to this, farmers are often forced into unprofitable transactions with local brokers and traders.

DrumNet's information access points or 'info-kiosks' are equipped with a computer with a dial-up connection to the Internet and a mobile phone (GSM) to link up with the central hub in Nairobi. This acts as the main server/database for storage and retrieval of information. Each is managed by an info-broker preferably from the local area. The individual info-kiosks have been designed to keep start-up and operating costs low and allow the info-brokers to reach rural areas typically untouched by such services. As members interact with the network, DrumNet will also compile data related to the credit worthiness of individual clients. This data will be in demand by financial institutions that have yet to tap into the market for micro-credit and other financial products in this part of Africa (Grogh, 2002). In the future, the DrumNet team envisages that its info-kiosks will be embedded into existing banks, savings and credit societies, as well as agricultural associations, and possibly even operated as independent franchises.

A similar initiative to that of DrumNet is run by the Kenya Agricultural Commodity Exchange (KACE), which links sellers and buyers of agricultural commodities. KACE launched an SMS-based information service, *SokoniSMS*[21], for farmers to receive market prices from markets in Kenya. This has enabled the farmers to bypass the middlemen who usually buy their products at very low prices. KACE has several market information points around the country from which they send price information to its headquarters in Nairobi. On its part, the team at the KACE headquarters uses a simple application that offers a web-based interface to update market prices onto the servers at the mobile phone network operated by Safaricom. The farmers are automatically charged Ksh. 7 (US$ 0.09) for each message delivered to their phones, but surfing the menu is free (Mungai, 2005). Figure 3 illustrates aspects of the service.

---

[21] 'Sokoni' is the Kiswahili word for 'market'.

Step1: A farmer types a message to retrieve market price information

Step2: The farmer sends the word MAIZE to the number 411 on the

Step3: The farmer receives a menu of market centers to choose from (main centers where

1 for Nairobi
2 for Nakuru
3 for Eldoret

Step4: The farmer sends a number for a given market center choice to the number 412

Wholesale price July 08, Dry KSh1450

Figure 3 [Source: Wainaina, 2005]

This is an excellent initiative in an economy that relies on agriculture as farmers can make more money even without increasing output. As a result, this may reduce the unsustainable demand on land to produce more.

The use of mobile phones to help farmers track prices is proving to be popular in the places where pilot projects have been undertaken especially because they are able to cut out the middle man. Some non-Kenyan examples include the case of Uganda's *FoodNet*, a Non Governmental Organization. It aims to get better prices for farmers by teaming up with a local mobile operator. *FoodNet* collects wholesale and retail price information for some 25 agricultural products that are updated daily into a database. Farmers can then SMS to obtain prices (ITU, 2004). In West Africa, farmers in Ivory Coast are also now able to keep track of commodity prices for coffee and cocoa through their mobile phones (Lopez, 2000).

Apart from this factor, some of the mobile telephony companies also actively support environment friendly initiatives as part of their corporate social commitments. It was not surprising therefore when the 2005 GSM Association nominated Save the Elephants (STE) Trust and the Kenya mobile operator, Safaricom, to be co-recipients of the 'Mobility in the Environment Award' for their innovative program of applying GSM mobile technology to monitor elephant movements. This is done by deploying GSM and GPS-enabled collars so that rangers and conservation groups can track elephant herds and ensure their safety over vast areas. The information has been useful in identifying key elephant migratory corridors that need to remain open. The information also helps STE to monitor poaching levels apart from being applicable to policy matters on animal reproduction (Safaricom, 2005).

There are a number of lessons to be learned from the growth of wireless technologies in Africa. They are faster and cheaper to deploy though growth only takes place when prices are lowered due to competition. The challenge the African mobile market faces is to sustain growth in the face of affordability constraints. Africa has a great future with mobile telephony, but how much people can and are willing to actually spend on communications is difficult to analyze because of informal markets and the lack of reliable income data.

4. 'Non-Mobile Phone' Wireless Technologies for Development

This section focuses on the 'non-mobile phone' wireless technologies in Africa. In general, the deployment of wireless technologies, such as, Wi-fi and Wi-Max, in Africa is still relatively new. It may be plausible to assume that their deployment may take the pattern of mobile telephony, but that is a matter for conjecture. The following are some of the projects of other wireless technologies in this respect.

There are a number of interesting pilot projects, for example, Morris's (2004) to address the needs of rural communities by exploring and implementing potential innovative low-cost technologies for Internet access. The "First Mile" refers to connectivity between access devices and access providers, but represents a more bottom-up analysis focusing on the end user. The technologies considered include Wi-Fi, wired Ethernet, powerline technologies, and bluetooth. The "First Inch" is a confirmation that technology must be adapted to the local environment and it is not enough to place it in the hands of users. This accounts for the project's focus on application and access devices operated by the end-user, such as PCs and handheld PDAs but it is not clear whether this is from a user's perspective. Another area of focus is the applications running on these devices such as Internet access, email, VOIP telephony, voicemail, instant messaging and related applications designed for the end user.

Some of the project's objectives (Morris, 2004:6) are to:
- explore the potential of innovative, low-cost information and communication "first mile" technologies;
- implement several "first mile" technology pilots in rural and peri-urban environments in Southern Africa;
- build business case assessments for "first mile" solutions, seeking scaleable, replicable, sustainable models for the deployment of these technologies;
- support the growth of a community of researchers in different countries who are engaged in exploring the potential of "first mile" and "first inch" technologies.

The project is composed of ten sub-projects and these are objectives of five of them related to wireless and development:
  i. *VSAT/Wi-Fi – Tsilitwa, East Cape (South Africa)* to enhance rural healthcare by piloting an innovative low-cost communications platform linking rural clinics to a hospital.

ii. *VSAT/ Wi-Fi – Inhambane (Mozambique)* to examine possibilities of reducing costs by sharing Internet connection among local users through wireless technology.

iii. *VSAT/Wi-Fi – Huambo (Angola)* to create a community telecenter in Huambo city.

iv. *VSAT/AX.25 for long distance connectivity and education-Nampula (Mozambique)* to use HAM Radio technologies to connect university students enrolled in distance education with their tutors.

v. *First Inch technologies and Human Computer Interface - Tsilitwa, Lubisi, and White River (South Africa) and Mozambique rural telecenter sites* to determine the application needs of several communities and design and implement the identified solutions.

The progress of these projects has not yet been documented for public access. It is expected that future phases could focus on extending the network and in exploring different activities in various African countries (Morris, 2004).

The ITU (2004) argues that the emerging advanced wireless technologies that have not even made an impact in developed countries have great potential in Africa where there is a clear market gap. These include the, 'Portable Internet' representing a new generation of advanced technologies and techniques that provide a platform for high-speed data access using Internet Protocol (IP). The second example is Wi-Fi standard (IEEE 802.11a and b), which offers connectivity at 11 or 22 Mbit/s over a range of up to 150 meters, using license-exempt spectrum in the 2.4 GHz band, is the best known of these standards. Others include radio-based standards, such as Wi-MAX (IEEE 802.16), which offers high-speed connectivity over a range of up to 50 kilometers, operating in bands that stretch from 10-66 GHz and from 2-11GHz (802.16a), without a requirement for line of sight (ITU, 2004:13).

Apparently, ISPs in Africa are already creating home-grown wireless access networks using imported wireless equipment. This has forced the regulators to act, as the existing GSM license holders do not want to see potential markets erode. Thus, in April 2004, the Nigerian Communications Commission gave notice to spectrum users to vacate the 2.4 and 5.8 GHz spectrum bands to enable the development of a licensing process to use these bands. It appears that in many African countries the legal position of ISPs offering WLAN services is vague. The main advantage is the growing installed base of WLAN receivers, which are standard in many new laptop PCs. The main disadvantage is the limited range to a common Internet connection, like in a university campus (ITU, 2004:14). An alternative to WLAN is fixed wireless access combined with VSATs to provide wireless access over a wider area. This is the option chosen by, Simbanet, a Kenyan wholesale ISP with franchisees in Tanzania and Nigeria to provide a 'wireless DSL' service within a range of 3-10 km from VSATs.

The Wireless Interoperability for Microwave Access (Wi-MAX) is another technology with great potential, which uses parts of spectrums that are hardly used. It has a range of up to 50 kilometers and is perceived to have the most to offer developing countries. This is not happening in Africa which made ITU (2004:14) to raise the question: "why not Africa? The quick answer is that it might be difficult at present to find an operator willing to take the risk, given the impact that this technology will have on existing "revenue streams".

As radio technologies and public policies evolve, an increasing amount of spectrum is being set aside for transmission use without a license. These license-exempt or "unlicensed" bands include 2.4 GHz and 5 GHz in the USA and much of Europe. Neto (2004) asserts that unlicensed spectrum and low-cost wireless technologies that operate in these bands have the potential of increasing access to, and availability of information and telecommunication services in developing countries. License-exempt spectrum enhances entrepreneurship because it reduces entry barriers and the risk of regulatory capture. To assess this opportunity, the author surveyed all African countries on their regulations and use of the 2.4 and 5 GHz bands. She received responses from 95 percent of the potential respondents (47 of 54 African countries), mostly from regulators.

There is significant diversity and heterogeneity in the regulation of these bands in Africa. For example, the criteria for licensing and certification vary in countries and so do power, range and service restrictions. She suggests that the lack of clarity in regulations and low enforcement may discourage potential players from entry (Neto, 2004) but this has to be confirmed by further research. Africa has a low teledensity, therefore, establishing a more certain regulatory framework and conducive business climate may give confidence to private investment in connectivity through technology in specific bands.

At present, these bands are being used in most African countries for 'hotspot' style and other coverage. 37 percent of the countries that responded are using wireless technologies operating in these bands to provide backhaul network connectivity in rural areas (Neto, 2004). It is noteworthy that in unlicensed bands, regulation tends to place a burden on the transmitter through power restrictions, in particular where competition in the market is low. Due to this factor, the author recommends that a fair balance is needed in regulation and that governments should err on the side of laxity to lower entry barriers and counter-balance the current over-regulation of these bands.

A number of authors, such as Chitamu and Naicker (2005), recommend that VSATs should be considered in areas with low population densities. However, Hudson (2003:6) argues that strategies to extend broadband often focus too much on technology. She believes VSATs may be an ideal solution to bring high speed Internet access to rural areas, but one should assess if it is legal in that particular country to install the VSAT which bypasses a public switched network. This is another legal and regulatory issue that is similar to the concern about license-exempt bands in Neto (2004). The answer lies in pushing for clarity in relevant regulations.

Despite these concerns, VSATs are mushrooming everywhere in Africa. In Rwanda for example, the total number of VSAT Narrow band is estimated to be over 400, mostly in the rural areas. One does not require a license to operate one in this country which has about twenty-five VSAT broadband. ISPs and international organizations mainly use them for voice and Internet access and it costs about US$5525 annually to operate a VSAT broadband (Nsengiyumva, 2004).

In Zambia, ZAMTEL which operates one of the key satellite gateways is unable to meet the demand for quality service. Consequently, each ISP has set up its own VSAT gateway for which it is charged US$1000 annually. The country's Zambia Revenue Authority (ZRA) has also developed a VSAT network for its stations spread across the country. If one looks at the volume of transaction going through the VSAT network, there is a lot of excess capacity that could be leased out to other institutions in similar locations like the Pensions Boards and other Government agencies. Most of the banking

institutions have also rolled out VSAT networks for their operations in Zambia with most of them being routed through South Africa (Munsaka, 2004). This is the case in many African countries, such as, Kenya where the banking sector were among the first groups to be allowed to use VSATs.

Although they recommend use of VSATs in areas with low population, Chitamu and Naicker (2005) point out that the boundary between the technologies together with actual traffic levels is a gray area that needs to be quantified. Thus, one of the aims of their study is to quantify the boundaries of suitable technologies and interconnection topologies based mainly on traffic levels. Their assumption was that technology choice plays a crucial role though the following have to be considered: demand, population density, traffic, coverage requirements, equipment costs, regulatory framework and spectrum availability. The example they used for traffic modeling is for rural Kwazulu Natal, the most populous province in South Africa that occupies only 8 percent of the country's landmass. To achieve this objective, they computed the estimated traffic for different coverage areas in Kwazulu Natal to demonstrate the expected traffic levels. They also used a voice and data service, based on a tree–structured Wireless Access System. It takes the form of a fixed cellular system with a LOS Microwave Backhaul from Base Stations to Base Station Controller which enables wide area coverage in low density rural areas.

In their analysis, the low figure of traffic per unit area indicates that the rural radio system is range rather than capacity limited. Therefore, it does not matter whether the Wireless Access System is based on TDMA or CDMA multiple access technology, provided the system meets the radio range requirements. Evidently, this is different from normal cellular system design where the aim is to improve the capacity of the system. They recommend some technologies that should be considered for rural areas which include:

- Wireless Local Loop (WLL);
- Cellular (IS-95, GSM, etc);
- Point-to-Multi Point Wireless Access;
- VSAT;
- Cordless (CT2, PHS, Digital European Cordless Telephone (DECT));
- Integrated / Combined VSAT / WLL;
- Integrated / Combined Microwave / WLL;
- Proprietary Solutions such as DaRT

(Chitamu and Naicker, 2005)

The shortcoming they found with WLL is that radio range is coverage limited. Consequently, it is not suitable for low-density traffic over large geographical areas. By way of comparison, VSATs are suitable for low-density traffic, but their cost of terminals and per minute service charge is high. When VSATs are used as backhaul technology, they are suitable for clustered rural areas capable of having integrated VSAT/WLL.

In Uganda, the ITU approved a project to extend Multipurpose Community Telecenters to rural and remote areas by testing the use of packet-based wireless IP technology. The project is being undertaken in conjunction with the Ugandan Communications Commission that is testing the use of Voice over IP (VoIP) as a precursor to possible regulatory reform. In addition, the Uganda National Commission for UNESCO is implementing a pilot project for establishing a national network of community multi-media

centers (CMC). The six CMC sites already possess community radio or Multipurpose Community Telecenter (MCT) facilities.

The pilot project has experienced several problems in relation to telecommunication infrastructure and has suffered from unstable digital links. Thus, the project aims to provide reliable connectivity to enhance the activities of Nakaseke Community Multimedia Telecenter and improve its networking with institutions in the vicinity. The plan to instal a VSAT and Wi-Fi link will provide Nakaseke with an affordable and reliable connection. Local institutions such as the Nakaseke Hospital, the sub-county headquarters, and the Nakaseke Teacher Training College will share the connection, the monthly usage fee and the annual maintenance fee. AFSAT Uganda will manage and maintain the VSAT and will provide training to the telecenter's technicians. Additionally, a solar panel will be installed to provide reliable and cost effective energy supply (Nakkaazi, 2004). There is not much information beyond the results of the pilot study.

Some practical examples of deployment of other wireless technologies can be found in the health and education sector.

4.1 Health

Reducing the cost of healthcare, while improving delivery, is a priority for Africa. Rural areas are beset with communication problems, but with mobile computing solutions such as low-cost handheld devices, database administrators can manage systems centrally without going to remote areas. It has been suggested that if patient information can be availed across GSM networks in rural areas, it would improve local healthcare delivery. After all, timely, accurate, and relevant information is essential for an efficient and effective health system. It requires investment however to have a delivery system supported by healthcare management systems (Engelbrecht, 2005). One of the most interesting projects on how handheld devices, specifically Personal Digital Assistants (PDA) are used by health workers for information sharing can be found in Uganda. Makerere University Medical School, HealthNet Uganda and SATELLIFE have engaged PDAs in the health sector to capture, store, interpret and retrieve patient information, and to manage pharmaceutical, financial, logistic and epidemiological information (Okello, 2004).

The PDAs connect to each other using a Wideray Jack. In this context, a remote server communicates with Jacks located nationwide over the existing mobile network and exchanging data that is forwarded to its final destination. The project was to be implemented in two phases over three years. Phase one covered the technical development and pilot tests, while the second phase would be the second and third year rollout. It was envisaged that once completed, the system would:

- Improve the quality of health data collection;
- Reduce the delay in the transfer of health data;
- Facilitate the rapid aggregation of data;
- Facilitate more timely analysis of data, and;
- Improve communication among healthcare professionals.

(Okello, 2004)

The preliminary results show that during the pilot phase, 70 health staff were given their own PDAs and 12 solar chargers; they were trained by HealthNet Uganda. There is evidence that through timely reports, timely decision-making and by cutting down costs of stationery and travel, PDAs have improved health service delivery in this region. The project team organized a workshop in May 2004 on the use of PDAs in the health sector in Africa, bringing together innovative healthcare initiatives from across the continent. They are currently planning to expand the network to additional districts and train more staff. A cost benefit analysis of PDA-based data collection versus traditional paper methods was also to be undertaken. According to the project leader Patrick Okello (Okello, 2004), one of the key challenges they face is not technology related, but the absence of a policy framework in the health sector for the integration of ICTs.

Wright (2004) also discusses the same PDA project in Uganda, but draws to attention a PDA project in Kenya that is not widely known. She writes that in Uganda and Kenya, 40 doctors and medical students have been equipped with electronic hand-held PDAs to help them with diagnoses, pregnancy calculation, and dosage recommendations. With the PDAs, they had access to drug catalogues and medical texts at the touch of a button and were able to check the information in real-time while they were with the patient, unlike previously when they had to go to libraries which could be costly to the patient's well-being. Health workers nevertheless expressed concern that fixing broken PDAs in Africa is very difficult. They were told the broken devices could not be fixed even in the USA, because they usually "just throw them away", which is not an option considering the cost to African citizens. However, this has not dampened the enthusiasm as many doctors are still willing to buy their own PDAs because they cannot function effectively after getting used to them.

Wright (2004) draws attention in addition, to an American Red Cross project undertaken in Ghana to investigate how technology could improve data collection. The data collection for a measles study using PDAs took only seven days and would have taken a few months without the PDAs. The importance of such an initiative is confirmed by Kearns (2002) who points that every year over 44 million children worldwide contract measles and 1 million of those die from the disease. In Africa alone, there are 12 million cases and 450,000 deaths per year. Measles, a disease that is practically non-existent in the developed world, is the single leading cause of death among children in Africa. In the summer of 2001, SATELLIFE teamed up with the American Red Cross (ARC) to use PDAs to conduct surveys of mothers and caregivers during a measles vaccination campaign in Ghana.

Thirty Ghanaian Red Cross volunteers used the PDAs to gather and submit useful data electronically for future measles immunization campaigns. This simplified the analysis process. According to E. Yaw-Dankwa (Information Officer, Ghana Red Cross) "most of (their) volunteers had never seen a PDA before, but they soon got comfortable with the devices and made good use of them in the field". In three days, they conducted 2,400 surveys in 67 locations of the Cape Coast region. If they had used the traditional paper survey method, they would only have done about 200 surveys in the same period. On this occasion however, survey data was easily transferred from each PDA to a laptop computer. Analysis was then completed and a full report was delivered to the Ministry of Health within hours. The entire pilot project was completed in less than a week, and the speed and ease of gathering this epidemiological data was unprecedented (Kearns, 2002). According to Darby (2004), it is predicted that in the next three years, the number of wireless device users will increase by 700 per cent. In health care, this growth has

become apparent with the advent of interactive connected hand held devices for clinicians.

4.2 Education

In the education sector, there is an interesting pilot project using Wi-Fi for education in the rural areas. This is the 'Rural Connectivity Project for the Global Education Partnership (GEP)' program in Kenya with an aim to provide cheaper, faster and more reliable Internet access to students of GEP's computer lab at Wundanyi, a rural town in the Taita Hills of Kenya. Prior to the project, the students only used the Internet for email, mainly due to the slow and expensive dial-up Internet connection. The lab provides training to enable poor young people to search for jobs or self-employment using the World Wide Web (Iland and Woodside, 2004). Iland was a Canadian volunteer in Kenya and Woodside was an online ICT volunteer in Canada. Woodside had explored the use of wireless links to provide Internet connectivity in rural Canada, and was able to advice Iland online which equipment was needed at Wundanyi. He recommended the use of Wi-Fi open spectrum wireless Internet technology to bridge the distance of 25 kilometers between Wundanyi and Voi – a larger town below the Taita Hills – where superior Internet access is available. The recommendation was to upgrade the current long-distance, dial-up connection of 4Kbps to a 33.6Kbps leased line with a speed of 28K, using an 802.11b wireless link between Wundanyi and Voi.

The Global Catalyst Foundation awarded a grant that enabled them to establish a wireless Internet link and Ethernet connectivity in the computer lab at Wundanyi (Iland and Woodside, 2004). GEP students are now be able to research information on the web at the Wundanyi lab and complete their course assignments, they will also be able to network with students at GEP's other branches in Tanzania, Guatemala, Indonesia and the USA. In addition, GEP's alumni will be able to search for jobs on the Internet and establish contact with international entrepreneurs. Iland's assessment on completion of his work in Wundanyi was that he had been taught to think beyond the standard applications of technology and to respect the skills and wisdom about technology that people gain without formal training (Iland and Woodside, 2004).

Another project that aims to empower communities and individuals to harness wireless networks as a point-of-access to ICTs for development is the 'Wireless Capacity-Building for Africa (WCFA)' project. It involves developing workshop content and providing training. The project also maintains a wireless broadband knowledge base, apart from creating partnerships and knowledge networks on wireless issues among IT professionals and policy makers in Africa (Tothill, 2004). In its initial phase, the WCFA team selected technical staff, IT managers and potential trainers who were taken through a series of workshops to acquire skills and knowledge that they could impart. They are thus able to set up community wireless networks and develop curricula as well as content for an online repository of information on wireless technologies, the impact of this project is yet to be widely assessed.

The projects on wireless and education in Africa tend to focus largely on institutions of higher learning. However, EduVision's focus is different. It has a pilot project at Mbita Point Primary School, located on the shores of Lake Victoria, a rural area in Western Kenya. The project, a joint undertaking of the Switzerland and Kenya-based Bio-Vision Foundation seeks to assist countries to improve their education systems by providing

appropriate ICTs for the classroom. EduVision's ultimate aim is to replace textbooks, notebooks and stationery with a single integrated system with multimedia content, which each student can use in the primary school sector. To reach this point, students will use eSlates, which are simple tablet computers designed for students and teachers, while the content will be disseminated through a satellite radio-based network. It is argued that this technology can be made available at a lower cost than the aggregate price of children's textbooks throughout their primary education (EduVision, 2005) but this is yet to be proven.

From a descriptive perspective, the EduVision E-Learning System (EELS) consists of the eSlate, the BaseStation and the Network Operations Centre linked to the WorldSpace satellite that already covers Africa and Asia. The eSlate is a large version of the PDA and will cost less than US$100 per unit by the time EELS is ready for large-scale implementation. It runs on a version of the Linux operating system. Among its other features are a built-in wireless network card and antenna that it uses to transfer data to and from the BaseStation. The latter contains a large hard disk drive, a digital satellite receiver, a wireless network card and a satellite phone. The BaseStation examines the content received and disseminates it to the correct eSlates via wireless network within the range of 100 meters. It can also collect assignments from the students' eSlates and transfer them to teachers for grading. The Network Operations Centre houses textbooks and other content destined for the eSlates via the Internet. Prior to this, the content is prepared for satellite transmission and assigned a 'tag' that describes which eSlates are to receive it (EduVision, 2005). The project is still in the pilot stage and it is difficult to assess its impact at this stage.

5.   Concluding Remarks

The problem of access in rural areas is a key area of concern. From the literature, there is evidence that there are many who are trying to address the problem of access to telephony with some measure of success. It is clear in addition that the use of wireless technologies is spread out over Africa with the most documented being mobile telephony. One feature of usage patterns is the tendency to share mobile phones in Africa. It is also the case that many successful initiatives are SMS-related. This may be an avenue for future initiatives.

The reasons for the success of mobile telephony in Africa, particularly when contrasted with the limitations of fixed lines, are amply demonstrated. It is worth concluding therefore that Africa's present and likely future telecommunication world is wireless. That is why farmers, fishermen, small business owners, and ordinary people are using mobile phones to perform a number of activities. The challenge the African mobile market faces is to sustain growth in the face of affordability constraints. Africa has a great future with mobile telephony, but how much people can and are willing to actually spend on communications is difficult to analyze because of informal markets and the lack of reliable income data.

The paper demonstrates the need for a new mechanism to measure mobile phone access in developing countries, like those in sub-Saharan Africa by distinguishing 'access' from 'subscription'. It is also inferable from this work that Africa needs to allocate more resources to rural telecommunications and invest in collecting data and

information on issues related to wireless technologies and their applications from the perspective of how these can be useful to the continent. As noted in the review, the challenge in sub-Saharan Africa is that the data is out there, but the problem remains how to source and analyze it.

As a way forward, there are evidently a lot of pilot initiatives and anecdotes. In addition, it was difficult to find literature assessing issues from a user perspective. Many projects are at the embryonic stage and others do not seem to have progressed beyond the pilot initiatives. Thus, it is hard to locate information even if it would be useful for development and replication in similar economies. In other cases, information is documented and then left to gather dust on shelves[22]. In practice, it would have required extensive travel and patience. Despite these demands, the information would be beneficial in the long run in understanding how wireless technologies are being used in Africa.

Another major challenge is that people are involved in interesting projects that they have not documented. They may not be willing to share this information because they think researchers on the projects have an ulterior commercial motive. This is a common position in many parts of Africa, where there is a feeling that projects have been 'over-researched' to the extent that local people are not able to benefit directly from them at grassroots level. This tends to encourage them to expect monetary compensation for project related information that could be used in several countries of the continent. Though critical, conducting primary research in Africa thus calls for much tolerance and sensitivity. It would be important to ensure that some of these pilot projects are translated into major initiatives with demonstration effects to give the people more confidence. This should convince policy makers who have influence in sustainability of such projects and users who can contribute to success or failure of these initiatives.

---

[22] It was difficult to physically access this type of information for the review because of limited time and resources.

List of Sources

Adam, L. (2004) 'Ethiopian Telecommunication Sector Performance Review'
March 2004 [Accessed 30 June 2005 from
http://www.researchictafrica.net/modules.php?op=modload&name=News&file=article&si
d=398]

Adjao, D. (2005a) 'Mobile Communication Technologies', 30 March [Accessed June 8, 2005 from http://www.mobileafrica.net/technologies.php] Confirm

Adjao, D. (2005b) 'Mobile phone handset market in Africa'. 30 March [Accessed June 8, 2005 from http://www.mobileafrica.net/technologies-mobile-phone-market-in-africa.php] Confirm

African Business (2002) 'Mobile users prefer prepaid', *African Business* July/August, *278*, 25

Ahmed, I. (1998) 'Telephones to Ring Change in Rural Bangladesh', Panos-Bangladesh, August 1998 [Accessed 20 May 2005 from
http://www.oneworld.org/ips2/aug98/14_23_053.html]

Allen, J.R. (2003) Rural Access to ICTs in Southern Africa. Proceedings of a workshop, February 12, 2003, Windhoek, Namibia [Accessed 20 May 2005 from http://tprc.org/papers/2003/269/RuralAccessICTs.pdf]

Ashurst, M. (2001) 'Now, a 'Quiet Revolution'' *Newsweek 8/27/2001*, Vol. 138, Iss. 9, p. 32, Aug. 2001, [Accessed 2 May 2005 from
http://search.epnet.com/login.aspx?direct=true&db=aph&an=5032101]

Badaru, S. (2004) 'Time to Fight Cell Phone Theft,' Technology Times [Accessed on 1 Oct. 2005 from http://www.techtimesnews.net/shina.asp?id=125]

Banda K. G. and M.T. Easterboy (2005) 'A Case of Gender and Income Generation for Empowerment of Malamangwa Community, Limpopo Province, South Africa' [Accessed on 2 May 2005 from http://www.afrepren.org/Pubs/articles/pdfs/ban_jesa.pdf]

Bayes, A. *et. al*. (1999) 'Village Pay Phones and Poverty Reduction: Insights from a Grameen Bank Initiative in Bangladesh.' *ZEF – Discussion Papers on Development Policy*, No. 8, Center for Development Research (ZEF), Bonn, June 1999 [Accessed on 20 July 2005 from http://www.zef.de/zef_englisch/f_publ.html]

Bourjolly J. *et. al.* (2002) 'Optimizing Frequency Hopping in GSM Cellular Phone Networks' *Telecommunication Systems* 21:2–4, pp. 249–260

Bridges.org (2003) ICT-Enabled Development Case Studies Series: Africa. [Accessed 6 June from http://www.bridges.org/iicd_casestudies/compliance/]

Business in Africa (2004) 'Telecom operators strike gold in Africa' [Accessed 16 Feb. 2005 from http://www.businessinafrica.net/features/telecoms/349759.htm]

Camp, J L. & B. L. Anderson (1999) 'Grameen Phone: Empowering the Poor through connectivity.' *iMP (Information Impacts)*, December 1999 [Accessed 16 Feb from http://www.cisp.org/imp/december_99/12_99camp.htm]

Castells, M. *et.al.* (2004) 'The Mobile Communication Society: A Cross-Cultural Analysis of Available Evidence on the Social Uses of Wireless Communication Technology'. A Research Report prepared for the 'International Workshop on Wireless Communication Policies and Prospects: A Global Perspective' at the Annenberg School for Communication, University of Southern California, Los Angeles, 8-9 October 2004

Chéneau-Loquay, A. and R. Ntambue-Tshimbulu (2005) 'What kind of cooperation for ICTs in Sub-Saharan Africa?' [Accessed 2 May 2005 from
 http://www.unige.ch/iued/wsis/DOC/285EN.PDF]

Chitamu P. and M. Naicker (2005) 'Peer-to-Peer Wireless Networking for Rural Telecommunications' [Accessed 2 May 2005 from
http://engineering.udw.ac.za/coe/Research/Zahira/rurcom.pdf]

Craig A. (2004) 'Vodacom, Vodago', *Economist*, Vol. 371, Iss. 8378, May 2004, p.60

Cronin, J. (2005) 'African's Mobile Entrepreneurs' [Accessed 30 Sept. 2005 from http://news.bbc.co.uk/2/hi/business/4145435.stm]

Daniell, G.R. (2005) 'Satcoms in Africa Strides Ahead', *Northern African Wireless Communications*, Vol. 4, No. 1, Feb/Mar 2005, pp. 22-24

Darby R. (2004) 'Five New Trends to Watch In Healthcare Information Technology' [Accessed 20 May 2005 from
 http://www.medimage.co.za/Richard's%20articles/five_new_trends.htm]

De la Serna, M. (2004) 'Kenya's Safaricom Starts New Roll Out Phase.' *Emerging Markets Economy*, Feb. 2004

Devlin, J. (2004) 'Can Africa Embrace Digital?' *Northern African Wireless Communications*, Vol. 3, No. 5, Oct/Nov 2004, pp. 22-24

Dholakia, N. (2002) 'The Global Digital Divide and Mobile Business Models: Identifying Viable Patterns of e-Development' [Accessed 16 Feb 2005 from
http://ritim.cba.uri.edu/working%20paper/Global-Digital-Divide0Development-Models-v7%5B1%5D.pdf]

Donner, J. (2005) 'The Rules Of Beeping: Exchanging Messages Using Missed Calls on Mobile Phones in Sub-Saharan Africa'. Paper Presented at the 55th Annual Conference of the International Communication Association, New York, 26-30 May 2005

Dot-ORG (2004) 'Village Cellular Phones in Uganda for Rural Income Generation and More' [Accessed 2 August 2005 from http://www.dot-com-alliance.org/newsletter]

Dudley, G. (2004) 'A Picture Costs A Thousand Words', *Finance Week*, June 2004, p.74

EduVision (2005) 'Development Powered by Education: The EduVision E-Learning System Pilot Project.' [Accessed 29 July 2005 from http://www.eduvision.or.ke]

Economist (2005) 'Calling Across the Divide', March 2005

Engelbrecht, D. (2005) 'Mobile, Wireless offer Innovative Approach to Healthcare Delivery' [Accessed 3 July 2005 from http://www.meridianhc.co.za/guestm&wde.html]

Engelhard, R. (2001) 'Wireless: A Help Line For Agricultural Development?' Report of the 4th Consultative Expert meeting of CTA's Observatory on ICTs, Wageningen (The Netherlands) 31 May - 1 June 2001

Engvall, A. and O. Hesselmark (2004) 'Profitable Universal Access Providers'. Report for the Swedish International Development Agency (SIDA) [Accessed 16 Feb 2005 from http://www.scanbi-invest.com/reports/?PHPSESSID=6746a56277e52bba4e2390af1274e9a4]

Esselaar, S. *et.al.* (2004) 'VSAT Case Studies: Nigeria, Algeria and Tanzania.' Research Report for the LINK Centre, University of the Witwatersrand, South Africa, 12 March 2004 [Accessed 20 July from http://www.researchICTafrica.net/images/upload/vsat%203%20case%20study%202004.pdf]

Garbus L. *et.al.* (2005) 'Is the Internet Relevant to Addressing HIV/AIDS in Poor Countries?' [Accessed 2 May 2005 from http://ari.ucsf.edu/pdf/Posters/barcelona/garbus/pdf]

Gamurorwa, A. (2004) "Uganda: a success story?" In K. Warnock and D. de Sarkar (eds.) (2004) 'Completing the Revolution the Challenge of Rural Telephony in Africa'. Report of The Panos Institute, London (UK), April 2004, pp. 18-23

Geser, H. (2004) 'Towards a Sociological Theory of the Mobile Phone'. *Release 3.0*, May 2004 [Accessed 16 Feb. 2005 from http:// socio.ch/mobile/t_geser1.pdf]

GOK (2003) 'State of the Environment Report for Kenya 2003: Emerging and Cross-cutting Issues'. National Environmental Management Authority, Government of Kenya (GOK) [Accessed 6 June from http:// www.NEMA.go.ke]

Goodman, J. (2005) "Linking Mobile Phone Ownership And Use To Social Capital In Rural South Africa And Tanzania". In 'Africa: The Impact of Mobile Phones', The Vodafone Policy Paper Series', No. 2, March 2005, pp. 53-65

Green D. (2003) 'South Africa: A Novel Approach to Improving Adherence to TB Treatment'. *Essential Drugs Monitor, Iss*. 33, pp. 8-9

Grogh V. (2002) 'DrumNet: an exchange for rural African entrepreneurs'*,* Pride Africa, [Accessed 28 July from http://web.idrc.ca/es/ev-47033-201-1-DO_TOPIC.html]_ and http://www.prideafrica.com/projects.htm]

Hall, J. (2003) 'Mobile Phones in Vogue in Africa', *Inter Press Service News Agency* [Accessed 16 Feb. 2005 from http://www.ipsnews.net/interna.asp?idnews=21536]

Hamilton, P. (2001) 'Africa: Burgeoning Growth, But Whither the PTO?'.
[Accessed 16 Feb. 2005 from
http://www.worldmarketsanalysis.com/InFocus2002/articles/telecoms_Africa.htm]

Hanias, G. (2005) '3G for All – Cutting Costs with OSS Billing'. *Northern African Wireless Communications*, Vol. 4, No. 2, Apr/May 2005, pp. 27-29

Herselman M.E and H.R Hay (2003) 'Challenges Posed by Information and Communication Technologies (ICT) for South African Higher Education Institutions', *Informing Science,* June 2003 [Accessed 16 Feb 2005 from http://proceedings.informingscience.org/IS2003Proceedings/docs/119Herse.pdf]

Hudson H.E (2003) 'Discovering Demand: Lessons from Wireless Competition in Asia and Africa' [Accessed 6 March 2005 from http://www.itu.int/ITU-D/treg/Events/Seminars/2003/Mongolia/45-Ref-Discovering%20Demand/pdf]

Hudson H.E (2005) 'Toward Digital Dividends in Africa: Lessons in Telecommunications Policy and Practice' [Accessed May 2005 from http://www.usfca/edu/fac-staff/husdon/papers/tdd-in-africa.pdf]

Hutchinson D. and M. Warren (2003) 'Security for Internet banking: A Framework' *Logistics Information Management,* Vol 16, No. 1, pp 64-73

Ibrahim, M. (2005) 'Mo's show'. *Economist,* Vol. 375, Iss. 8420, p.58, April 2005 [Accessed June 2005 from
http://search.epnet.com/login.aspx?direct=true&db=buh&an=16607344]

Iland, Y. and S. Woodside (2004) 'From Wundanyi to the World Wide Web – Kenya'. Report of the Rural Connectivity Project by Global Education Partnership [Accessed 20 July 2005 from http://www.unites.org/cfapps/WSIS/story.cfm?Sid=16]
ITU (2004) African Telecommunication Indicators 2004. International Telecommunication Union, Geneva, May 2004
Jason, P. (2001) 'Nigeria: Mobiles for a few', African Business, 269, p. 39
Jensen, M. and D. Richardson (1999) 'Wireless weaves to lessen the gaps in rural telecommunication coverage in Africa' [Accessed 24 May 2005 from http://www.fao.org/WAICENT/FAOINFO/SUSTDEV/CDdirect/CDre0025.htm]

Jensen, M. (1996) 'A Guide to Improving Internet Access in Africa with Wireless Technologies.' IDRC Study, August 1996. [Accessed Feb. 2005 http://www.idrc.ca/acacia/studies/ir-jens.htm]

Jensen, M. (1999) 'The First Mile of Connectivity: Wireless Weaves to Lessen the Gaps in Rural Telecommunication Coverage in Africa'. *SDdimensions*, July 1999 [Accessed 8 June 2005 from
http://www.fao.org/WAICENT/FAOINFO/SUSTDEV/Cddirect/Cdre0040.htm]

Kearns K. (2002) 'PDA Results: Social Mobilization a Success, Red Cross Society'. [Accessed 28 July 2005 from http://www.measlesinitiative.org/ghanaj.asp]

Kerton, L. (2004) 'Could Africa Become the Global Leader in Next Generation Wireless Broadband', *Northern African Wireless Communications*, Vol. 3, No. 4, Aug/Sept 2004, pp. 31-33

Kibati, M. (1999) 'Wireless Local Loop in Developing Countries: Is It Too Soon for Data? The Case of Kenya.' M.S. Thesis, Massachusetts Institute of Technology [Accessed June 2005, http://rpcp.mit.edu/Pubs/Theses/WLLThesis.pdf]

Kibati, M. and K. Donyaprueth (1999) 'The Wireless Local Loop in Developing Regions.' *Communications of the ACM*, Vol. 42 Iss. 6, p. 60, June 1999
[Accessed 2 May 2005 from
 http://search.epnet.com/login.aspx?direct=true&db=aph&an=11937107]

Kiplang'at J. (2003) 'Does Agricultural Extension Have A New Beginning Because Of Icts? Reflections On Experience In Sub-Saharan Africa' Paper presented at ICT observatory 2003: ICTs – Transforming Agricultural Extension, Wageningen (The Netherlands), 23-25 September 2003 [Accessed 16 Feb 2005 from http://www.cta.int/observatory2003/keynote_papers/Keynote_Africa.pdf]

Knight P.T. (1996) 'Destined to Leapfrog: Why a Revolution in Learning will Occur in Brazil, Russia and South Africa.' Paper prepared for the Second International Conference on Distance Education, 2-5 July 1996, Moscow, Russia [Accessed 16 Feb 2005 from http://www.intelecto.net/textos1/conferencias/s5_1.pdf]

Lawson, C. and N. Meyenn (2000) 'Bringing Cellular Phone Service to Rural Areas: Grameen Telecom and village pay phones in Bangladesh.' Public Policy for the Private Sector, No. 205, March 2000
[Accessed May 2005 http://www.worldbank.org/html/fpd/notes/205/205lawson.pdf]

Lopez, A. (2000) 'The South Goes Mobile,' *UNESCO Courier*, July/August 2000
[CONFIRM….http://www.unesco.org/courier/2000_07/uk/connex.htm.]

Mbarika V. *et.al.* (2002) 'Cyberspace Across Sub-Saharan Africa: Moving From Technological Desert Toward Emergent Sustainable Growth.' *Communications of the ACM,* Vol 45, No. 12, Dec. 2002, pp. 17-25

Morris, C. (2004) 'First Mile, First Inch (FMFI)'. In 'Connectivity Africa Infobook' pp. 5-8 [Accessed Feb. 2005 from http://www.connectivityafrica.org]

Mungai, W. (2005) 'Using ICTs for Poverty Reduction and Environmental Protection in Kenya'. Report for the 'Next Generation Policy Directions Project: Exploring Linkages between Development and the Information Society' for the International Institute for Sustainable Development (IISD), June 2005

Munsaka, J.S. (2004) 'Performance of the Country ICT Sector: The Case for Zambia', March 2004 [Accessed 30 June 2005 from
http://www.researchictafrica.net/modules.php?op=modload&name=News&file=article&sid=398]

Mureithi, M. (2003) 'Self-destructive Competition in Cellular: Regulatory Options to Harness Benefits of Liberalisation' *Telecommunications Policy*, Vol. 27, Iss. 1-2, Feb. 2003, pp. 11-19
[Accessed May 2005 from
http://www.elsevier.com/wps/find/journaldescription.cws_home/30471/description#description]

Mureithi, M. (2004) 'Kenya Telecommunication Sector Performance Review: 1999-2003' March 2004 [Accessed 30 June 2005 from
http://www.researchictafrica.net/modules.php?op=modload&name=News&file=article&sid=398]

Mutula S.M. (2003) 'Cyber cafe´ Industry in Africa.' *Journal of Information Science*, Vol. 29, Iss. 6, pp. 489– 497

Mutula S.M. (2003) 'Assessment of Africa's Telematics, Policy and Regulatory Infrastructure: Potential for E-learning.' Paper on "Changing Working Conditions in Higher Education**"** delivered at the NTESU International Conference, University of Natal, South Africa, 9-11 July 2003

Nakkaazi, A. (2004) 'Satellite Communication for Community Development: Nakaseke Telecentre.' In 'Connectivity Africa Infobook' [Accessed Feb. 2005 from http://www.connectivityafrica.org]

Nsengiyumva, A. (2004) 'Rwanda Telecommunication Sector Performance Review' April 2004 [Accessed 30 June 2005 from
http://www.researchictafrica.net/modules.php?op=modload&name=News&file=article&sid=398]

Neto M.I. (2004) 'Wireless Networks for the Developing World: The Regulation and Use of License-Exempt Radio Bands in Africa'. M.S. Thesis, Massachusetts Institute of Technology (MIT) [Accessed May 2005 from http://www.itc.mit.edu/research/studentthesis]

Nguo, J. (2005) 'Role of ICTs in Rural Development', Paper Presented at the Second National ICT Convention, Nairobi, Kenya, March 2005

Niang, I. (2004) 'Senegal ICT Resource Centre: Creating R&D Capacity'. In 'Connectivity Africa Infobook' [Accessed Feb. 2005 from http://www.connectivityafrica.org]

Nicola M. and M. Jarke (1998) 'Design and Evaluation of Wireless Health Care Information Systems in Developing Countries'. Proceedings of the IFIP 9.4 Conference on Implementation and Evaluation of Information Systems in Developing Countries, February 1998.

Nzepa, O. N. (2004) 'Cameroonian Telecommunication Sector Performance Review', April 2004 [Accessed 30 June 2005 from http://www.researchictafrica.net/modules.php?op=modload&name=News&file=article&sid=398]

Odame H.H. and J. Atibila (2003) 'Linking Agricultural Research and Rural Radio in Africa: New Opportunities for Communicating Innovation and Experiences from Northern Ghana.' A CTA ICT observatory case on 'ICTs Transforming Agricultural Extension' [Accessed 16 Feb 2005 from http://ictupdate.cta.int/index.php/filemanager/download/69]

Okello, P.A. (2004) 'Application of Hand-held Computers in the Delivery of Health Services in Uganda.' Paper presented at the Conference on Innovative Applications of ICTs in Local Governance in Developing Countries 7-9 June 2004, Addis Ababa, Ethiopia

OKN (2005) OKN Mobile. Open Knowledge Network (OKN), One World International, February 2005, [Accessed 30 June 2005 from http://uk.oneworld.net/article/view/117272/1/ and http://uk.oneworld.net/article/view/117283/1/]

Otieno, E. Y. (ed.) (2005) 'Text Your Way to a New Job', *The Option*, Safaricom Magazine (Kenya), Issue 15, April-June 2005, pp. 22-23

Padgett J.E. et al (1995) 'Overview of Wireless Personal Communications' IEEE Communications Magazine, January 1995

Reck, J. and B. Wood (2003) *What Works: Vodacom's Community Services Phone Shops*. Seattle: World Resources Institute

Repokari L. *et. al.* (2002) 'Visual Search on a Mobile Phone Display.' Proceedings of the South African Institute of Computer Scientists
and Information Technologists Conference, pp 253 [Accessed 16 Feb. from http://portal.acm.org/citation.cfm?id=581548&dl=ACM&coll=portal]

Rose G. *et. al.* (2003) 'The Role and System Characteristics of Internet-Voting in the Republic of South Africa: Looking Inside a Multi-cultural, Nascent Democracy.' Research paper presented to the 11th Annual CCRIS meeting in South Africa [Accessed 16 Feb 2005 from http://tigger.uic/edu/~evaristo.p3.pdf]

Rydhagen B. and L. Trojer (2005) 'ICT And The Role Of Universities - A Technopolitical And Postcolonial Challenge.' ITDG closing symposium on 'Information Technology, Transnational Democracy and Gender' [Accessed May 2005 from http://www.luth.se/depts/arb/genus_tekn/manus_BRY_LTR.pdf]

Safaricom (2005) 'Innovative Mobile Technology Program Helps Track Elephant Herd Movement.' Safaricom Ltd, Feb. 2005 [Retrieved on 29 July 2005 at and http://www.save-the-elephant.org/PDF%20Files/gsm-june04-web.pdf and http://www.safaricom.co.ke]

Samuel, J. *et.al.* (2005) "Mobile communications in South Africa, Tanzania and Egypt: Results from Community and Business Surveys". In 'Africa: The Impact of Mobile Phones', The Vodafone Policy Paper Series, No. 2, March 2005, pp. 44-52

Shanmugavelan, M. (2004) 'Mobile Africa Must Not Leave Its Villages Behind' *Contemporary Review; Jul 2004*, Vol. 285 Issue 1662, p33 [Accessed July 2005 from http://search.epnet.com/login.aspx?direct=true&db=aph&an=13988409]

Simpson D. (2002) 'Togo: Mobile Frenzy as Bond goes in for the Kill.' *Tobacco Control,* Vol. 11, pp 173-174 [Accessed June 2005 from http://tc.bmjjournals.com/]

Sridhar, K.S. and V. Sridhar (2004) 'Telecommunications Infrastructure and Economic Growth: Evidence from Developing Countries'. Working Paper of the National Institute of Public Finance and Policy (NIPFP), India

Stone, B. (2004) 'Your Next Computer.' *Newsweek*, 7-14 June 2004, pp. 65-68

Telecommons Development Group (2000) 'Grameen Telecom's Village Phone Programme: A Multi-Media Case Study.' March 2000 [Accessed Feb 2005 from http://www.telecommons.com/villagephone]

Tothill, A. (2004) 'Wireless Capacity-Building for Africa (WCFA)'. In 'Connectivity Africa Infobook' [Accessed Feb. 2005 from http://www.connectivityafrica.org]

Tusubira, F. F. *et. al.* (2004) Uganda Telecommunication Sector Performance Review'

April 2004 [http://link.wits.ac.za, Under RIA network publications under LINK CENTRE]

Ulfelder, J. (2002) 'Upwardly Mobile', *World Link,* Vol. 15, Iss. 2, pp. 48-51

UNCTAD (2001) 'The Digital Economy: Integrating the LDCs into the Digital Economy.' At the Third United Nations Conference on the Least Developed Countries, Brussels (Belgium), May 2001 [Accessed Feb. 2005 from http://www.unctad.org/ldc3/parevents/digital.en.htm]

Walton M. and V. Vukovic (2003) 'Cultures, Literacy, and the Web: Dimensions of Information "Scent"' *Interactions,* March – April 2003 [Accessed Feb 2005 from http://portal.acm.org]

Warnock, K. and D. De Sarkar (eds.) (2004) 'Completing the Revolution the Challenge of Rural Telephony in Africa'. Report of The Panos Institute, London (UK), April 2004

Wolf, S. (2001) 'Determinants and Impact of ICT use for African SMEs: Implications for Rural South Africa' Paper prepared for TIPS Forum, Misty Hills, Muldersdrift, 10-12 September 2001 [Accessed Feb 2005 from http://www.tips.org.za/f2001/world.pdf]

Wright, B. (2004) 'Technology Delivering 'Amazing' Results.' *African Business*, Iss. 299, June 2004, p. 44-45 [Accessed June 2005 from
http://search.epnet.com/login.aspx?direct=true&db=buh&an=13395426]

Zachary P.G. (2004) 'Black star: Ghana, Information technology and development in Africa' *First Monday,* Vol. 9, No. 3
[Accessed March 2005 from http://firstmonday.org/issues/issue9_3/zachary/index.html]