Internet for Everyone in African GSM Networks

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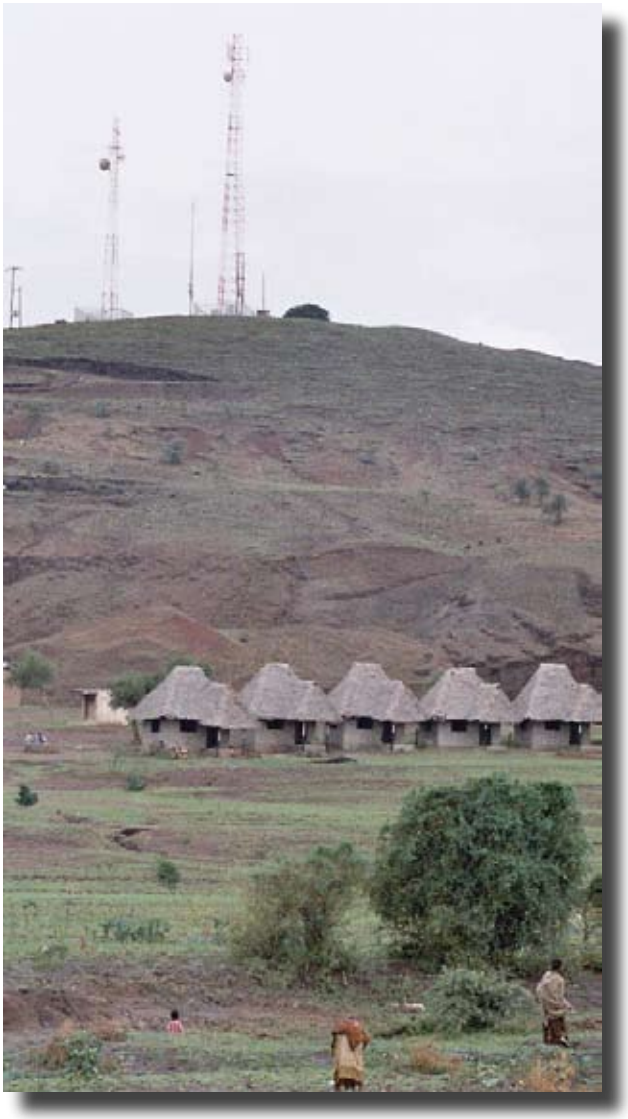

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Executive Summary

This report present the results of an investigation of the technical and commercial viability of using GSM technology for providing wireless data services on a large-scale basis in Sub Saharan Africa. The study objective was to investigate the business cases for data services considering the very special situation facing mobile operators in Africa. Essentially, the objective was to investigate whether GSM would be a financially viable solution for offering Internet services to vast areas in Africa, particularly since no other alternatives are available in the short term.

Privately financed GSM operators in Sub-Saharan Africa have in a few years created a completely new telecom infrastructure with a capacity far greater than what the state owned telecom authorities have provided in 100 years. More than 100 operators are active in the continent, most with great financial success. Expectations of future growth in subscribers and revenues continue to mobilise investment capital for expansion.

At the same time, Internet access is lagging behind, and most African nations are far behind in their use of ICT. Access is limited to the inadequate fixed networks or expensive VSAT connections, restricting Internet access to the traditional economic centres. The new GSM networks have wider area coverage, and the built-in GPRS/EDGE standard can provide wireless data services wherever the GSM networks reach. Data services can become an important future revenue source for a GSM operator.

So far, only a few operators in Africa have implemented GPRS and started to sell data services. For the remaining ones, there is a question about the business case for GPRS and EDGE. All operators know that the number of GPRS customers will only be a fraction of the voice subscribers, and that the revenue base for data services is rather small. Introducing GPRS services require additional investments that may compete for management's attention with further investments in coverage, in order to meet sometimes-aggressive competitors.

We have shown in this report that GPRS services are profitable even for small operators. There are therefore very strong reasons for starting to address this market in order to ensure that revenue growth continues even after the growth in the voice market has begins to taper off. In addition, there is a strong upside in profitability for those operators that can secure a good market share by addressing the difficult distribution issues.

The report highlights the importance of low-cost, dedicated data terminals for the emerging markets. Certain initiatives are under way and their success is a prerequisite for Internet services to become a mass market in Africa. Without such terminals, the Internet penetration would remain below one percent, slightly above the fixed line penetration.

The process towards GPRS has started and this report can help the operators in working out their own business cases based on their own special conditions. This report can also help African Governments to realize that there is a new opportunity to get Internet services to a very large percentage of their population. Many national ICT plans exist, but very few of them have taken the GPRS opportunity into account. How many Government officials in Africa realize that it is technically and financially feasible to equip all secondary schools with Internet access via GPRS? No other technical alternatives exist that would be as cost efficient.

Background

In our Study "Profitable Universal Access Providers" we have demonstrated that universal telephone access can be achieved without subsidies in rural areas with very low incomes. GSM operators in developing countries expand rapidly and enjoy very high profitability. The costs of establishing and running a GSM network have been reduced dramatically with economies of scale and strong competition between network suppliers. Special attention to mass production of low-cost GSM handsets will reduce prices, making them affordable also to poor families. There is no longer any doubt that GSM has won the race for voice services in low-income countries.

As a consequence, the mobile networks now give voice access to large and growing parts of the population in these countries. In nearly all countries in Africa, 50 % of the population will have mobile coverage in a few years. By the second quarter of 2004 the annual growth in Africa was 15 million new users, and the annual rate of growth was 56%.

In contrast to the fast growth of mobile telephony, Internet use has not had the same success. One fundamental reason is that Internet access still is tied to the fixed networks, which are not keeping pace with the investments in mobile networks. This is a direct result of most revenue growth taking place in mobile services. In addition, the available Internet connections are expensive and of low quality in Africa[1]. Users are not getting value for money from existing ISPs, and the result is slow growth.

Against this background, it is obvious that the "digital divide" will not be solved by traditional means like relying upon fixed line or cable networks for Internet access like in the industrialized world. The rapid spread of GSM networks and its wide geographical coverage could help to solve the problem of access to the Internet. Since GSM networks are capable of carrying data traffic, they clearly have the potential to become the primary bearer of IP services and to make wireless Internet available to the same population who have access to GSM services today in Africa. However, for this to become a reality for a large percentage of Africa's population, the data services on GSM networks need to be priced and structured differently from what has happened in Europe.

Study Objective

This report present the results of an investigation of the technical and commercial viability of using GSM technology for providing wireless data services on a large-scale basis in Sub Saharan Africa. The study objective was to investigate the business cases for data services in emerging markets – the revenue and cost base for such services, considering the very special situation facing mobile operators in Africa.

Essentially, the objective was to investigate whether GSM would be a financially viable solution for offering Internet services to vast areas in Africa, considering that no other alternatives are available in the short term.

The results presented in the report could be useful to the development community trying to address the digital divide issues as well as to the mobile operators planning to introduce data services on their GSM networks.

1 When we refer to Africa in this report, we mean Sub-Saharan Africa excluding South Africa.

The African Communications Market

Mobile growth

Mobile telephones are now a common phenomena in almost all countries in Africa. Initially covering cities and large towns, network coverage is rapidly reaching the rural areas where the majority of Africa's people live. In Sub-Saharan Africa, a few countries (Uganda, Kenya, Senegal) have already reached 10 % penetration and almost full population coverage in spite of low per capita incomes. The relatively wealthier countries of South Africa, Gabon, and Botswana have reached 20 % penetration. In the rest of the countries, average penetration is between three and four percent, with a total of about 30 million users in 2005.

Networks in Africa are still at their initial growth phase, and large investments in new capacity continue to be made by over one hundred individual operators. An average 10 % penetration for all countries in Sub-Saharan Africa would mean 65 million mobile users and there are good prospects that this level will be reached in the next few years. Foreign owners and financiers are behind most operators, which are run on purely commercial principles. Cash from revenues is in many cases financing investments in new capacity, an unusual situation in Africa considering that the operators are just a few years old. The following two maps shows the mobile coverage in 2004 and Africa's population density.

Mobile coverage and population density

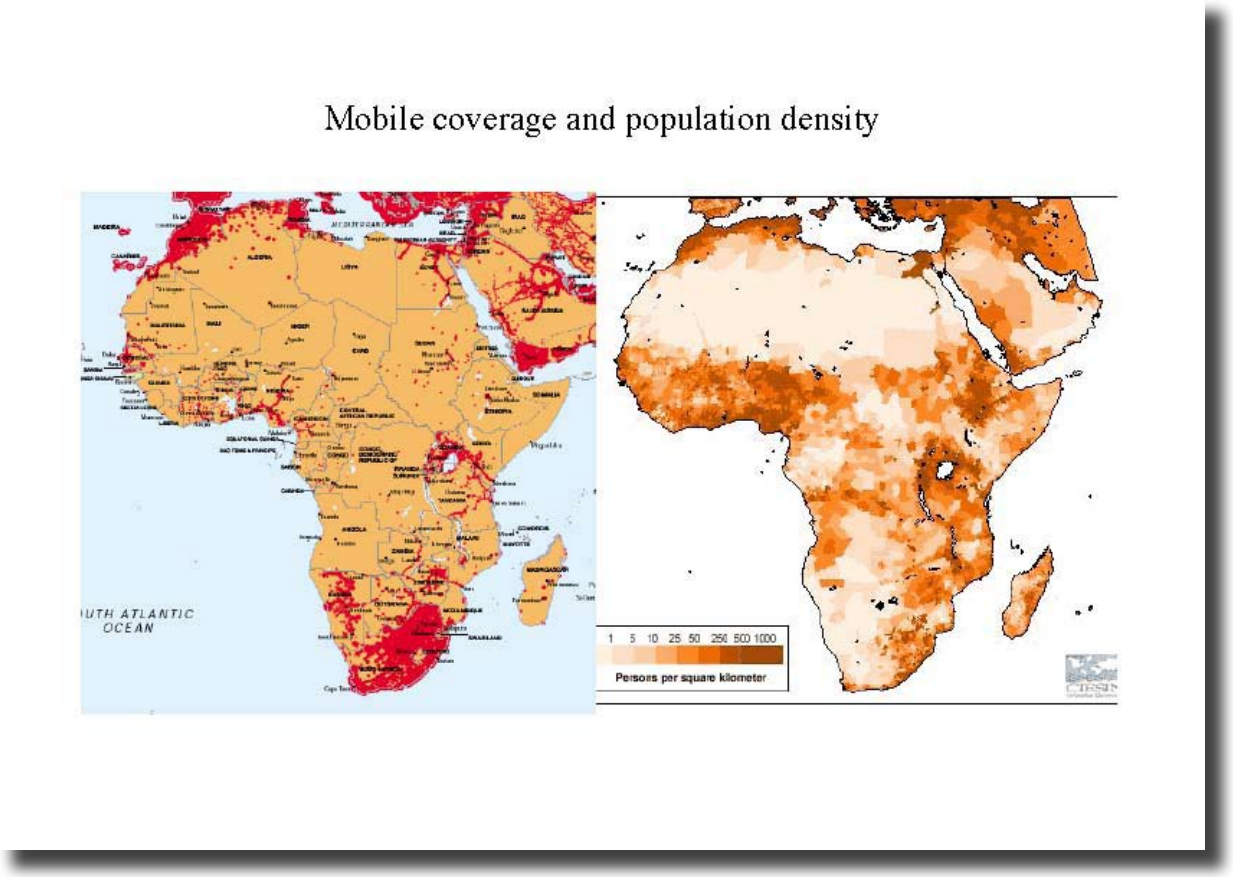

Fig 1. Source: GSM map from GSM Association. Population map from SEDAC, Columbia University,.

The maps show that mobile networks are only beginning to cover the vast rural areas where the majority of the people live. Full or almost full population cover has been reached in South Africa, Namibia and Botswana and in the Mediterranean states in North Africa. In other countries, for example Angola and Ethiopia, the GSM networks are only in their initial stages of expansion.

There are a number of reasons why the rate of adoption is as different as it is. One is political, as in the case of Angola. During the civil war in that country, the risk for investors were at maximum level, and very little foreign investment would find its way there. The creation of a national GSM network requires a great deal of money and many technology specialists, which in turn demands a certain level of stability and security. Angola is therefore a late starter as far as GSM infrastructure goes, but there is now little doubt that a rapid deployment is underway. As a contrast, South Africa has had cell phones for over ten years now, enjoys political stability, maintains a welcoming investment policy and its population has one of the highest purchasing power in Africa.

Another important reason is a country's investment climate and its telecom policy. Ethiopian authorities are reluctant to allow foreign investment, and all telecom business in the country is reserved for the state owned telecom monopoly. The telecom company has been unable (or unwilling) to raise the large sums of money needed for a national rollout of a GSM network.

A third reason is the general business climate in the country. Nigeria is often described as one of the worst countries in the world to do business in, with extremely high business risks. In this case, a long battle over licences delayed the process for several years, and it was only in 2002 that the networks were initiated. As soon as the licence issues were resolved, however, large amounts of venture capital were made available. The growth has been phenomenal, and Nigeria is likely to reach ten million users during 2006.

ITU Study on African Internet markets

Internet use in Africa has been steadily increasing from a modest start in the late 1990s. The growth has by no means been as explosive as for mobile phones, but Internet services are now common throughout the continent, wherever fixed telephone services are available. The reliance on the fixed network is the main constraint for further growth, together with extremely high costs for access and bandwidth.

The most recent comprehensive report about the Internet in Africa was published by the ITU in "African Telecommunication Indicators 2004". According to the report, all Sub Saharan countries with low-income levels had less than two Internet users per 100 inhabitants. The number of users includes in this case also those in Internet cafés and other shared facilities. The data is rather unreliable, but some general observations can be made.

Country	Internet acct:s	mobiles	mob/acct
Congo	700	328 953	470
D.R.Congo	6000	1 418 000	236
Cameroon	5500	1 045 263	190
SierraLeone	800	114 000	143
Uganda	7000	780 225	112
Burundi	800	65 000	81
CôtedIvoire	15200	1 230 344	81
Lesotho	1700	116 000	68
Senegal	9600	576 981	60
Mauritania	5000	292 685	59
Nigeria	53200	3 063 592	58
Guinea-Bissau	1000	50 000	50
Rwanda	2300	106 000	46
EquatorialGuinea	1000	44 290	44
Gabon	7800	300 536	39
Ghana	20100	768 211	38
Kenya	45000	1 575 508	35
Benin	6800	236 108	35
Chad	1800	61 176	34
Mozambique	15000	415 467	28
Gambia	4000	100 049	25
Botswana	20000	434 963	22
BurkinaFaso	10600	229 048	22
Zambia	12000	240 294	20
Tanzania	50000	884 211	18
Togo	12500	220 000	18
Mali	15000	246 429	16
Madagascar	18000	279 184	16
Angola	9000	132 158	15
Namibia	15500	223 699	14
Sudan	60000	675 000	11
Djibouti	2100	23 779	11
Réunion	50000	555 571	11
Malawi	12600	137 600	11
CapeVerde	5000	52 387	11
Guinea	11000	112 582	10
Niger	2400	23 333	10
CentralAfricanRep.	1300	12 400	10
Ethiopia	11400	95 455	8
Mauritius	58000	457 566	8
Zimbabwe	83000	399 280	5
Swaziland	19000	88 118	5
Comoros	1000	2 155	2

Table 1. Internet and telephone users in Africa. Source: ITU

The ITU report also contains data on the cost of an Internet connection in each country. The prices are given for 20 hours of Internet use per month. Also here, the variation is remarkably high – from $15 in Mauritius to $175 in Central African Republic. The middle range is between $40 and $100 per month for an Internet connection. Compared to mobile telephone tariffs, an Internet connection costs the same as 120 minutes of airtime in Senegal and 450 minutes in Tanzania.

In comparison with local incomes, the Internet is a very expensive service. ITU have compared the annual cost of an Internet connection with the per capita income in different countries as shown in fig 2.

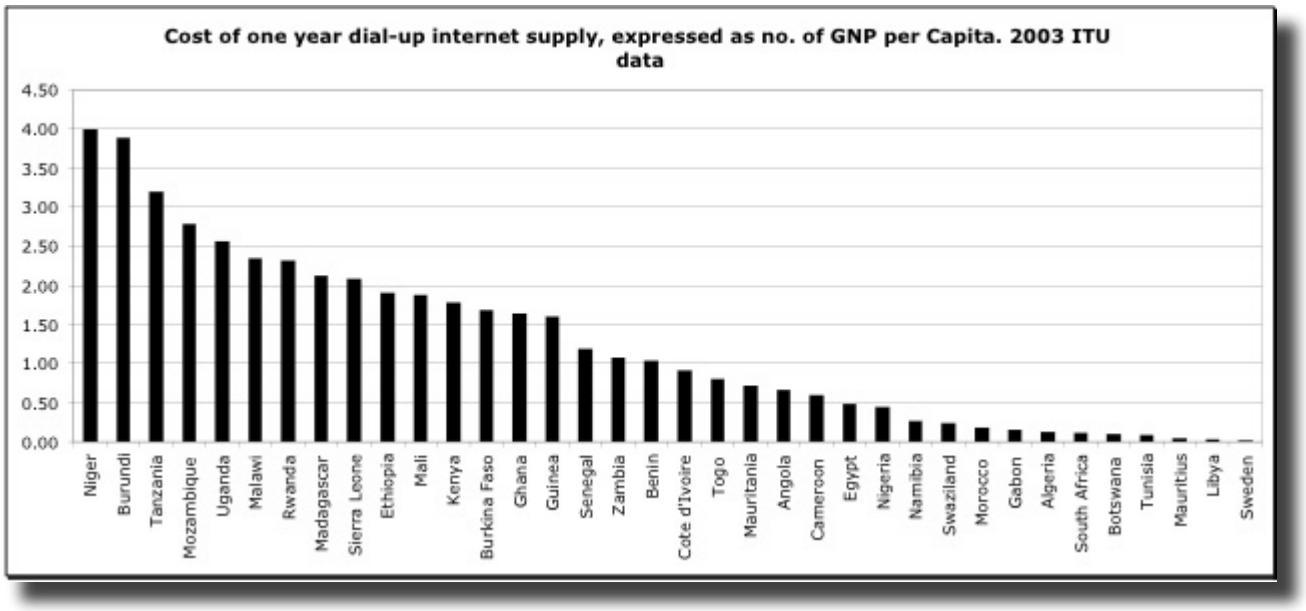

Fig. 2. Relative Internet costs. Source: ITU

With prices like these, it is clear that Internet services are only affordable to a minority of the population. They also explain the very high degree of sharing via Internet cafés and other communal access solutions that are common in Africa. The Internet cafés help to segment the market, offering a limited but affordable service to low-income users. Shared facilities are a necessity also for other reasons, because most of the café customers have no access to fixed telecom services. Most will, however, have a mobile phone.

The Internet market is thus characterised by very large variations between countries. It is in most cases very immature with high birth and death rates among Internet upstart companies. There are a few international Internet providers such as Africa Online, operating in several countries, but in most cases the ISP business is local. It is common that the incumbent fixed line operator owns the leading ISP.

Availability of Internet devices

In all Sub-Saharan countries, the access to Internet-enabled devices is particularly limited. There are in general few PCs, and a large part of them are not connected to the Internet. No reliable statistics are available, but we would estimate that as many as half of the existing PCs are not connected. This low penetration of PCs sets a limit to the Internet market.

The number of GPRS enabled phones is also small. Other handheld devices like Blackberry terminals are not used because of the absence of GPRS services in the networks. At present, only Safaricom in Kenya and MTN in Uganda have launched GPRS services, in addition to Vodacom and MTN in South Africa.

Africa's Special Situation

Different conditions in Africa

Looking towards the future of Internet in Africa, the Sub-Saharan countries have very special conditions because of their very limited fixed line penetration; it amounts to less than 1 percent. Considering that the costs of building a mobile network is about one third of the costs of a fixed line technology, the gaps between mobile to fixed subscribers will only increase from the current proportion of 10:1. For Internet penetration in Africa to take off, new approaches are necessary and the traditional reliance on fixed and cable technology is not relevant from a business perspective.

As many studies show, voice is the primary driver behind ICT development in emerging markets. It is therefore only logical to turn towards the GSM technology and investigate whether Internet could be piggybacked upon the commercial GSM voice systems. GMS systems are particularly attractive in Africa where more then 95 percent of mobile cellular technology is based upon the GSM standard[3].

It is clear that IP services over GSM network would face a completely different market reality in Africa compared with what has been the case in the OECD countries. GSM operators in developed countries now offer GPRS/EDGE[4] services to their customers. These services are generally value added services, offered as a mobile alternative and complement to the basic data services provided via the fixed or cable network. It is never considered as the primary IP service to any market segment. The operators can therefore charge heavily for the mobility offered by GPRS/EDGE and the services are essentially used when mobility has a high value. The customers are mainly business users and the private usage is limited.

In Africa, the situation is dramatically different since there are few alternative access possibilities besides the GSM infrastructure outside the largest cities. The only means of access in the foreseeable future would be via the GSM networks. The demand is for basic Internet services and the mobility aspect of GPRS/EDGE is next to irrelevant.

Why GSM?

The very simple answer to the question "Why GSM" is that it is the only alternative for Africa that would be financially viable for wide spread access to data services.

We are aware that new wireless connectivity alternatives are being developed and deployed very rapidly, like the WiFi, WiMax and CDMA 450. We would even admit that WCDMA would be a cheaper technology to deploy in many green field operations and that it would be more appropriate for carrying data traffic. The key issue, however, is that GSM is already deployed on a massive scale and much of the necessary infrastructure is already in place. The ability to piggyback on GSM voice is what makes GPRS and EDGE commercially interesting. Not only has the infrastructure been paid for by the voice services, but also the mobile operators are in many cases legally prevented from reselling capacity to other operators. The most important infrastructure is the backhaul transmission networks, which could not be accessed by new entrants.

The phenomenal growth of mobile networks in most countries in Africa has resulted in the incumbents not being able to deliver necessary transmission capacity. The incumbents have generally been granted monopoly for some years over the transmission services, both domestic and international. However, very rarely have they been able to provide the needed capacity, which has resulted in the mobile operators being allowed to construct microwave facilities for their own use. Facing a great pressure from the public to pro-

3 The CDMA licenses in Africa are essentially for Wireless Local Loop (WLL) services.

4 GPRS and EDGE are acronyms for General Packet Radio Services and Enhance Data for Global Evolution and are used for offering packet switched data services on GSM networks

vide mobile services to new areas, the national regulators have had no choice but to allow this to happen.

Another important issue in favour of the GSM operators is the international access that is essential to the end users of Internet. International data links to USA and Europe would be required for getting access to the Web. The GSM operators are already the largest generators of international traffic and are increasingly getting international gateway licenses. In addition, most of their international traffic is already being handled via TCP/IP. The marginal cost for the international access would thus be lower for the GSM carriers than for any ISP or similar company. Much of Africa's international traffic is still carried on satellite links, making the international access expensive.

Data services over GSM Networks

Fixed networks upgraded to provide ADSL are ideal for high volume Internet use, since the access network is unaffected by the volume of traffic. Regular telephone conversations can also be carried out concurrently with data transmission. The limitations are in the line itself, and in the transmission and server capacity of the network. This is the main reason for ADSL generally being offered at fixed subscription price with unlimited use both as regards data volumes and time.

This is not the case in wireless GSM networks, where the capacity for service delivery is limited by the available radio spectrum at each radio base station. Even if a radio base station can be upgraded to give more radio channels, GPRS/EDGE services will always compete for capacity with ordinary voice services. Therefore, the revenue capacity of a network is determined at each RBS, as a mix of voice and data. For data traffic, this is a clear disadvantage of mobile networks versus fixed line alternatives.

There is however one big advantage for mobile networks over fixed lines. The network does not need to know where the potential customer is located – this applies of course both to data and voice services. This is particularly important for GPRS and EDGE rollout since the uncertainties surrounding the market are very big. If rollout of GPRS services on one RBS turns out to be very successful with many new customers, the capacity can easily be upgraded. It would only be rare occasions in densely populated urban areas where additional cell sites will be needed.

Value of Data Services

Before turning to estimating demand from a bottom-up, micro-economic perspective, we need to look at the value of the data services in relation to the bandwidth requirements. Since the radio spectrum is limited, the bandwidths of wireless data services are considerably lower than for fixed line alternatives and certain high data volume traffic will not be possible to offer.

Fortunately, there are different types of data services, with varying bandwidth requirements, and with great variations in user value. Internet services can be separated into three broad categories: Communication services (basically email and document transfer), information services (general Internet use and browsing) and entertainment services (music, video and games). These three categories are related to bandwidth use and user value as described in the following table:

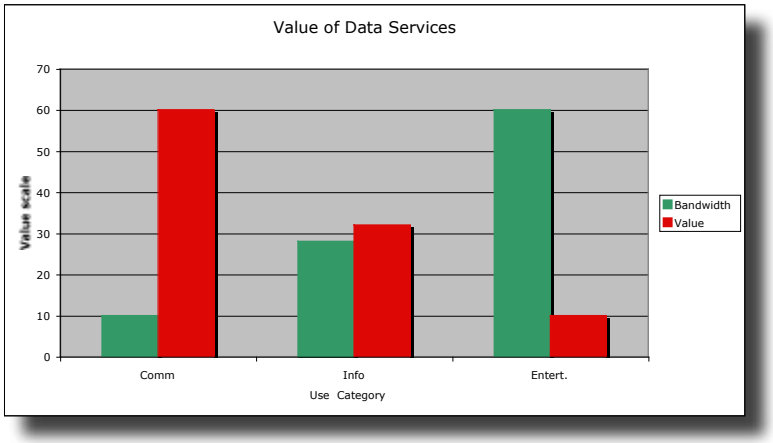

Fig 2. The relation of bandwidth use to the value of various types of Internet use.

All services that are directly connected with personal communication (email, document transfer) are highly valued by all users. SMS is a good example of this, since it is probably the most expensive data service in the world when expressed in price per KB. We estimate that these services would constitute the primary demand for Internet services via GPRS/EDGE and be the most important reason for paying for Internet access. This is very much the case in Africa, where personal budget resources are small compared to Europe.

At the other end are different bandwidth hungry applications, like interactive games, music and video transfers. These types of services cannot be provided via GPRS/EDGE as demonstrated by a simple example; A 750 MB DVD movie costs about €20 to buy. The equivalent cost per MB is 2 € cents, and as long as the usage fee is higher than this amount it is cheaper to buy the DVD than downloading it. In Europe, the current costs of data over GPRS/EDGE varies between €0.5 and €2.0 per MB, at which price it would cost €375 to €1500 to download a movie, hardly an attractive option for a movie fan.

Internet Usage

The limited availability of data access in Africa makes it difficult to make a reasonably accurate demand assessment. The market has not really taken off yet and existing data on usage is therefore not very relevant. We can take Uganda as an example.

This is a country with very liberal telecom regulation and licenses for telecom services can easily be obtained. It has already a high mobile penetration in relation to GDP per capita figures. The statistics in Table 2 have been taken from Uganda Communication Commission's web page:

Subscribers/Year	**1996**	**2001**	**2004**
Internet	4,200	6,000	8,000
Fixed Lines	58,000	56,000	71,000
Mobile	72,000	276,000	1,040,000

Table 2. ICT users in Uganda. Source: UCC web site.

These data reveal a typical pattern found in many African countries. Fixed line and Internet growth was slow in 2004, while mobile use was skyrocketing. The number of Internet accounts in Uganda was one in ten fixed lines, but just one in 250 mobile users. The most important barriers of entry for Internet usage are the small number of PCs, lack of reliable electricity and the absence of fixed lines.

Even if no official waiting lists exist for Internet access, we can assume that there would be a large pent-up demand, considering the limited access possibility to Internet services. Under these market conditions, customers are less price-sensitive since there is in essence a queue of customers waiting for getting a first access opportunity.

GPRS prices in OECD countries

After an initial few years of greatly varying prices for GPRS data services, European and US operators now seem to have settled for a rather unified pricing model. Almost all operators now offer GPRS as an add-on service to their mobile voice plans, with a monthly price for a given amount of data throughput. The plans normally vary from 5 MB per month to unlimited usage. We have examined the offers from 15 European and US operators and the result is shown in Fig. 3. In this diagram, we have converted the prices for each plan to € per MB, and added a regression line to show how the

prices follow a similar pattern for all the operators.

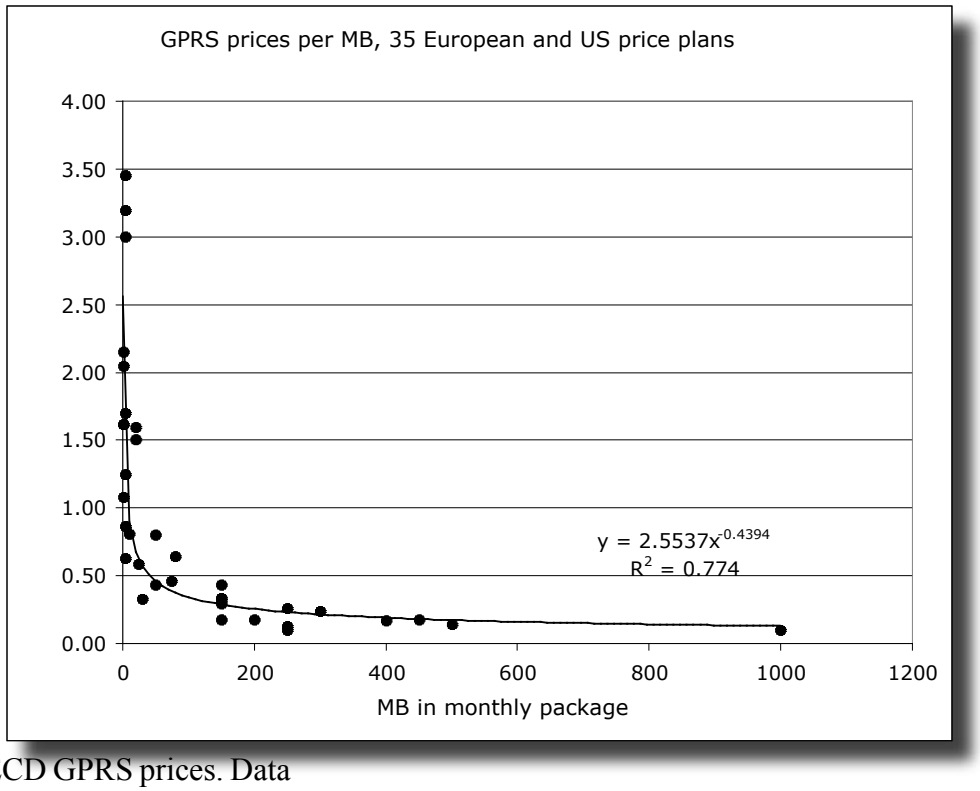

Fig. 3. OECD GPRS prices. Data from 15 EU and US operators' web sites. Sept 2005.

In Europe and the US, high volume data plans (250 MB and above) all cost €0.25 or less per MB, far below the voice revenue generated per radio spectrum unit. The exponential shape of the data above implies that operators are charging a fixed fee per month. Why operators choose this pricing scheme is not easy to know, since the details surrounding a "data package" are rather obscure. If a service offer includes some typical ISP elements, i.e. server or portal access, email accounts etc., it may explain the fixed fees.

All low volume plans (5MB or less) cost from €0.9 to €3.50. These prices demonstrate that low volume users are not welcome, another aspect that demands an explanation. It is not far-fetched to assume that the high prices for low data volumes have been set in order to protect SMS, MMS and content products from competition from email, Internet browsing and perhaps VoIP use.

Emerging Price Levels in Africa

In Kenya ten hours per month on dial-up is the equivalent of 55 MB per month at Safaricom's initial offer of €0.32[5] per MB. In South Africa the relation between fixed line minutes and MB is different. 10 hours per month of dial-up time costs € 48[6]. This buys 400 MB GPRS at the current data rates € 0.12 per MB from MTN or Vodacom. In Kenya, GPRS is priced attractively for low volume users, but in South Africa it is cheaper for all. MTN in Uganda have also recently launched GPRS services. Their price is a fixed € 36 per month for unlimited use.

5 Converted from Ksh 30 per MB

6 Using an exchange rate of ZAR/€ 0.20

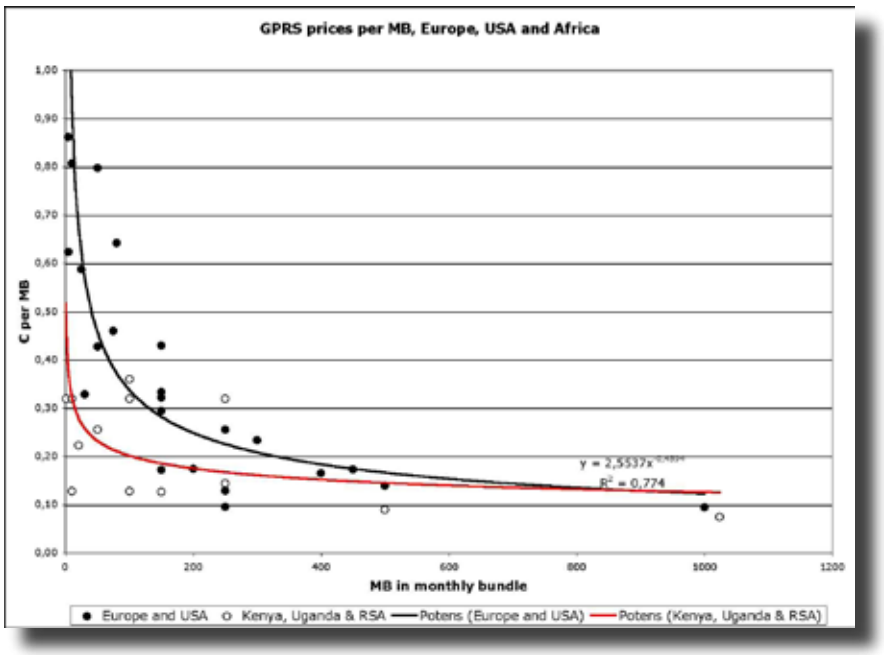

Fig 4. GPRS prices in Africa and Europe.

Adding these African GPRS rates in figure 3 above, gives some interesting results. The bend on the African curve is much lower down on the MB scale, implying that the volume discounts take place much earlier. This is a clear indication that the initial GPRS operators in Africa are more aggressively addressing the small users and the mass market. Even if it might be too early to tell, this could be interpreted that they are targeting the large market of users for primary Internet access.

During one hour of mixed Internet browsing on a narrowband (30-50 kbps) connection, a normal user would get a throughput of about 5MB (combining the traffic on the up and downlink). To open a server based mailbox, download and send a few e-mails, one would use less than 0,5 MB. For low intensity users, paying by MB is a better option, while users who are online for more than one hour per day would benefit from MTN's fixed monthly price in Uganda.

For the operator, it is important to know not just the average behaviour of the customers, but the distribution as well.

Getting the price right is a balancing act for the operators. Mobile voice tariffs in Africa are generally lower than the corresponding GSM voice rates in Europe. Judging from the initial tariffs offered by MTN and Vodacom in South Africa, their GPRS rates are clearly below the average rate in Europe. Even if the rates of Safaricom in Kenya and MTN in Uganda are higher than in South Africa, they are still lower than Europe. The early market entrants will most likely set the tariff levels for the followers and we could expect the rates to stay at around half of the European rates.

Another interesting approach would be to equate the cost of mobile voice call to the GPRS load on the network. A voice call cost typically € 0.30 per minute in Africa. With 13 kbps for a voice channel, one minute is the equivalent of 780 kbits data which would give a GPRS cost of € 3.1 per MB. This would thus be the opportunity cost of substituting data for voice in a case where there is no free capacity in the network, i.e. at peak loads. As has been shown above, market prices are far below from what could be expected from this byte for byte comparisons.

Bottom Up Market Assessment

Introduction

Due to the difficulties in assessing the market based upon available statistics and lack of established Internet services, we elected to make a bottom-up approach for a representative area. We selected an area in Tanzania which we are reasonably familiar with and where we would be able to verify our assumptions. The results could then be extrapolated for countrywide coverage. We build a simulation model as described in Annex 1 that incorporates the various variables described in the following.

Customer Groups

In order to bring more structure to our analysis of the market, the potential Internet customers have been separated into a number of groups. Each group consists of companies or institutions with different size and propensity for Internet demand. This classification is used in our design of a generic simulation model later in this report. Each of the customer groups is briefly described below.

International Organisations and NGO's

Embassies and other international organisations located in the country and the full spectrum of international NGO:s. These organisations have high communication needs. Larger embassies often have their own secure satellite connections, but the Internet is increasingly becoming the carrier for non-classified communication. The foreign employees of this category will in most cases have private Internet accounts in addition to their work place connection. There is a good possibility that GPRS can replace expensive VSAT based connectivity for some members of this category. Many NGO's are located outside the major urban areas without access to fixed lines. They should be an important target group for narrowband Internet connections.

Central Government

The Internet and email is not yet in widespread use in African administrations. Most government offices are still lacking intranets with Internet links, and dial-up connections through the congested switchboards, or via specially designed lines is often the only alternative. GPRS access via the mobile network could be an attractive alternative for many government offices, if a suitable business solution can be found. It is very likely that easy access to email and other data services for this category will bring forward a large number of users, as government agencies start to get connected. The productivity gains are large, when electronic communications substitute today's mail methods.

Higher Education

Teachers, researchers and students all benefit from easy access to the Internet. They use the Internet to search for information, and to exchange emails and documents needed for their work and studies. This requires good access to PCs and connectivity. The reality is, however that connectivity is often reserved for a few institutions, the university's ICT centre is always one of the best provided. GPRS can be a low cost solution to widespread access, while the institution is waiting for funds for broadband and campus-wide WiFi.

Large Business

In Africa, large business has in most cases intensive international connections. International companies have always secured connectivity for their own use, in some cases by building their own satellite based communication systems. For example, a bank customer in Livingstone, Zambia, has his check processed by a computer in Nairobi. The information travels on the bank's proprietary IP link, completely outside the national telecom network. These solutions are in most cases very costly, and GPRS based alternatives may be very attractive for some large business.

Medium and Small Business

This category probably has the greatest potential for growth.

First, these companies are many, and this is a category where there are a great number of new entrepreneurs. Small and medium businesses are increasingly becoming aware of the advantages of electronic communication with customers and business partners. With easy access to connectivity over the GSM networks, many new customers will come forward. The number of users in each company will be just one or a few, and easy access with GPRS will be very attractive.

Local Government

In Tanzania, for example, there are over one hundred districts, each with a small administrative centre. These district offices typically house a number of functions, very often with PCs installed for office use. In most cases they are not connected, often because lack of funds or fixed lines. With GPRS, these offices are a prime target group for low cost e-mail services.

Education (Schoolnet)

A special case of users with low budgets and relatively high Internet browsing are the secondary schools. The number of schools with computer facilities is increasing rapidly as a result of various Schoolnet activities. Measurements made by such initiatives[7] indicate a monthly usage level of about 500MB download per month for a school with open access to the Internet and an Internet lab with five to ten PCs. Catering for these users in a GPRS/EDGE network will require special tariffs, as the school budgets for connectivity often are very limited.

7 Compare data available at www.schoolnet.na

Private users

This group have in many cases no fixed lines at home, or lines with low quality. To-day, many rely on Internet cafés for their email and Internet use. GPRS will offer a cost effective and convenient alternative, and we expect the number of users to grow rapidly.

Competition

In most countries in Africa, the limited coverage of fixed services, together with low service quality in many areas, is holding back Internet use. When GPRS/EDGE services are offered on mobile networks, the standard procedure is to offer these services on a network-wide basis. The immediate effect will be a dramatic increase of the supply of services and about fifty percent of the population could become potential customers of Internet services. The reason for this is that GPRS services would have the same coverage as regular GSM voice services.

These new users will not – in contrast to all existing ISP customers – be offered just another alternative, but a completely new service, without competitors (as long as one operator is alone with the GPRS rollout). GPRS/EDGE will offer them a better than dial-up service where nothing was available before. Depending upon the business model chosen by the mobile operators, this situation would create an opportunity for the ISPs to address a very much enlarged market and we expect the ISPs to become strong proponents for the GPRS/EDGE services.

Competing with existing ADSL services will be more difficult. To give an example of pricing let us take Senegal. A 256 kbps ADSL line with unlimited use costs € 44 per month, the equivalent of 1000 minutes (16,7 hours) of local dial-up time. At this price level, dial-up accounts have all but disappeared in one year. Even competitively priced EDGE would not be able to compete seriously with ADSL at these rates. Even if ADSL is very competitive, there are less than 1 percent of the population that can get access to this service (when offered). This situation will remain in the future, since fixed networks are hardly being expanded at all.

Technical Considerations

What are the key cost bearers?

Introduction

When making our cost estimates for providing data services over GSM networks, we considered only the marginal costs for upgrading the networks to GPRS and EDGE and for dealing with the additional traffic load on the network. The reason is that voice services are the volume traffic that will always be preceding the data introduction and be able to bear the major infrastructure costs. Our calculation will therefore not include the investment costs for the establishment of main transmission lines, international gateway facilities and infrastructure for the radio base stations (RBS). We would like to point out that such infrastructure could be very expensive in the African environment, particularly since most rural areas lack reliable power supply and much of the telecom equipment requires air conditioning.

Our key argument for studying Internet services via GSM network hinges upon the concept of getting better utilization on the existing infrastructure by adding data services that will bring in additional revenues at low incremental costs. Even if data revenues were relatively small in comparison to voice revenues, they would pave the way for continued revenue growth once universal population coverage is achieved and the growth in voice subscriptions levels off. This is particularly interesting in rural areas with little other prospects for further growth once basic service is established. Most operators experience very fast traffic load take-up on a new RBS in a rural area. Typically a rural RBS is filled to 70 percent of design capacity within the first year of operation. However, the growth thereafter is almost insignificant. Provided the rural RBS is GPRS/EDGE capable, there is 30 percent available access capacity for data traffic at no cost to the operators. A similar situation would most likely exist also on the transmission back haul links.

GPRS

GPRS is the acronym for General Packet Radio Services and as the name indicates is a packet switched data service. It is operated as an overlay system on the GSM network, which volume voice service is circuit switched. The technical implementation is achieved by taking one or several time slots on the radio channel for data, which is modulated (by a technique called GMSK) to achieve improved transmission speeds. The user data speed is about 20 kbps per time slot, which gives a theoretical maximum of some 160 kbps if all the 8 time slots are used. The higher data rate will, however, never be achieved in an African environment for two main reasons.

A rural RBS is typically equipped with 6 TRX for a BTS with 3 sectors. It is obvious that the number of time slots for GPRS would have to be limited in order not to impair the quality of the voice traffic. 8 time slots would take up 50 percent of the capacity of one sector and this would not be commercially justified; revenues from bursts of data traffic at high speed for short duration would not compensate for lost voice revenues. Depending upon the voice load, we would expect the allocation of available time slots be limited to around 4[8].

Another main reason is the availability of GPRS terminals that can handle a high number of time slots. Africa would need cheap GPRS terminals and they would not be able to handle more 2 to 4 active time slots. In fact, the GSM Association do not at present list any terminals on their web page that can handle more than 5 active time slots. The terminals are configured differently for the number of up- and downlink slots depending upon primary usage.

8 The suppliers offer different capabilities of configuring the availability of GPRS time slots. The key suppliers are able to make a fixed allocation of GPRS time slot as well as dynamic allocation of additional time slots if not required by the voice traffic. This is an essential feature for improving spectrum efficiency for both data and voice traffic. Data traffic can be dynamically suppressed at peak hours for voice.

For the purpose of our study, we estimate that the user available data speeds would be around 40 kbps. This is in line with figures published by GSM Association as well as what is found in system suppliers' documentation.

GPRS has very short connection times and provides the user with a feeling of being always connected. This is a big advantage over dial-up connections. The spectrum efficiency is also high, since many users can share the same time slots. They only get allocation of capacity when data is transmitted.

GPRS is relatively straightforward to implement in the network (billing could be more complex as explained below). The architecture is standardized and it can be deployed in a multi vendor environment with different suppliers of RBS equipment. Another advantage is that GPRS coverage is similar to voice with small degradation in signal strength (about 2 db) which implies that existing BTS locations can be used intact. Two new central nodes are required plus software upgrades in the RBS equipment to activate the function of Packet Control Units. Considering that the African GSM networks are very young, we would assume that all RBS equipment is GPRS capable. Even if the central nodes are relatively expensive, the total investment costs per RBS or per subscriber is very modest since the whole national network becomes GPRS capable at once and shares the costs of the central nodes.

Fig 8 shows the GPRS architecture in a Nokia network.

The two GPRS specific nodes are the Serving GPRS Support Node (SGSN) and the Gateway GPRS Support Note (GGSN), which in the Nokia case is called Intelligent Service Node, since it includes additional features over what is required by GGSN standards[9].

The main SGSN functions are mobility management, traffic routing and user authentication and authorization. Other essential functions are signaling to the MSC and collection of billing data. The GGSN act as a gateway between the GPRS network and the public data network, in other words ensures the access to the Internet.

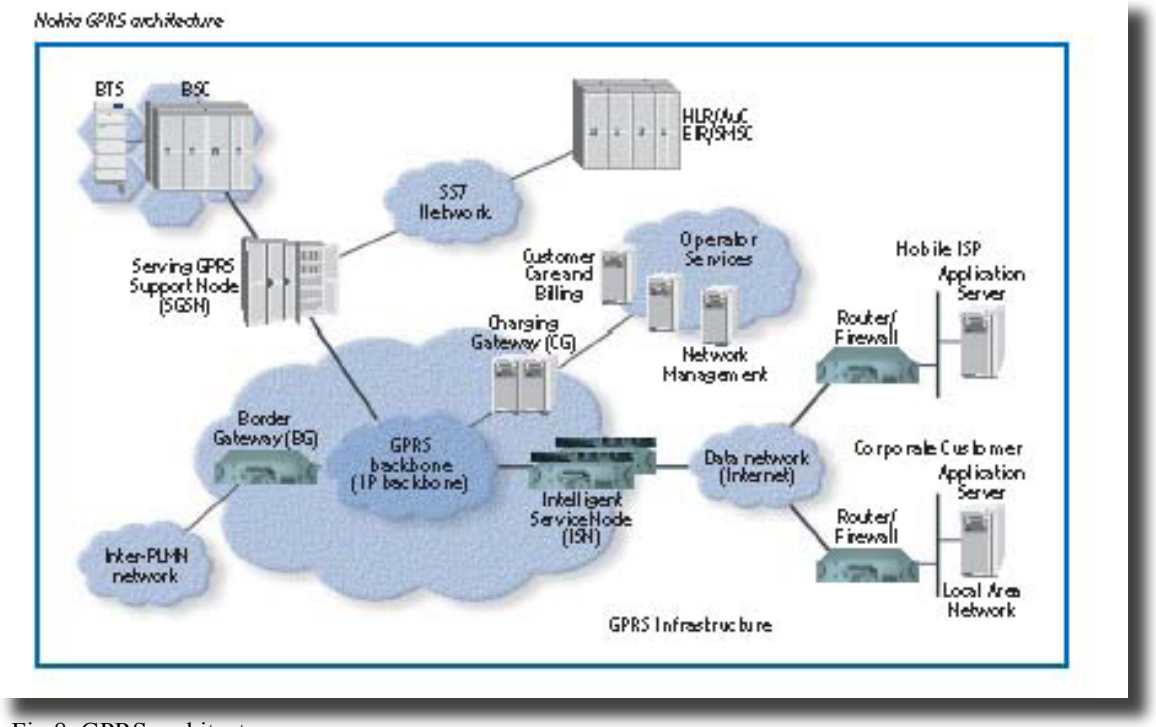

Fig 8. GPRS architecture.

9 Good descriptions of the GPRS system are found on the GMS Associations web site, www.gsmworld.com.

EDGE

EDGE stands for Enhance Data for Global Evolution and improves GPRS by increasing the data speeds. It builds upon, is an add-on to GPRS and requires all the GPRS network facilities. Essentially it provides improved modulation techniques and channel coding which results in significantly higher throughput and capacity.

EDGE modulation technique (called 8-PSK) enables three times as many bits per time slot as GPRS and the user data rate is about 60 kbps per time slot. Similarly to GPRS it is theoretically possible to allocate all 8 time slots, which would give speeds at 470 kbps. However, with the same argument as above for GPRS regarding voice having priority and availability of terminals, the expected EDGE speeds would be around 120 kbps.

A special feature of EDGE is that it offers a number of coding schemes (of which there are nine in total), which contains error correction and adapts to different signalling strengths. This feature ensures very high reliability of the data streams but is achieved at the cost of declining data speeds with distance from the base stations. While the vendors claim that EDGE is more robust than GPRS and reaches out even further than the voice coverage, this is achieved at reduced data speeds. Another important difference from GPRS is that EDGE requires many more dedicated time slots from the TRX to function satisfactorily. It differs in implementation from the different suppliers, but no supplier would need less than 4 time slots. In addition, EDGE would need more transmission infrastructure. A nationwide deployment of EDGE would probably necessitate updated radio planning and additional BTS deployment if the objective were that the distant customers in rural areas would perceive a significant improvement in data speed over GPRS.

For young networks, upgrading GPRS to EDGE would involve only marginal additional expenses. Most major vendors claim that their BTS equipment have been "EDGE ready" for some years and would only need a software upgrade that could be handled remotely. Considering that Africa's GSM networks are very young and their rapid growth, it should be considerably less expensive to deploy EDGE in Africa than in Europe's mature GSM markets. In addition, Africa doesn't need to consider UMTS as a competing technology for some years to come.

Costs of Upgrade to GPRS/ EDGE

Providing cost estimates for upgrading to GPRS and EDGE standards is very difficult due to the absence of a clear price structure for Africa. There have been many instances in recent years of complete equipment swaps between vendors, which have distorted the price picture for data upgrades. The GPRS/ EDGE features are often offered at very low costs and in some instances free of charge instead of a discount on the total equipment costs. List prices on EDGE upgrade are therefore meaningless in Africa at present.

A GPRS upgrade essentially consists of two central nodes in the network. We have checked with several sources to find information about the actual prices paid for GPRS upgrades. In most cases, the upgrades to GPRS are made in connection with major network expansions and list prices are therefore rarely paid. For all our scenarios below, we have used a network upgrade cost of € 600,000, which we consider to be a realistic market price. We only use one price, since the smallest capacity of the SGSN and GGSN nodes far exceeds the needs of the data volumes studied.

Interviews with Celtel International show that it is much more difficult to make cost estimates for EDGE upgrade. EDGE is a superior technology to GPRS for data services. Its higher spectrum efficiency improves throughput of up the three times that of GPRS. The issue is however the complexity of multivendor networks. In certain cases the output power might have to be lowered to accommodate the EDGE capability, forcing replanning of network coverage. In other cases not only some TRXs need to be replaced, but also entire BTS. Considering this uncertainty, we decided that we will primarily base our cost benefit analysis upon GPRS roll out and work on the assumption that once sufficient number of users are obtained, the operators would have better information to ascertain the viability of EDGE upgrade. Considering the limited availability of EDGE terminals at affordable cost, it would most likely be premature to launch EDGE on a countrywide basis at this stage.

International Access

In the developed world we take international access to the Internet for granted at very low costs both to the operators and the consumers. Unfortunately, this is not the case in Africa, where only the SAT3 submarine fibre cable serves western and southern Africa, while East Africa and the inland countries rely on satellite channels for their international access. The difference between West and East Africa in costs to the mobile operators – at least those not being owned by an incumbent - is not as large as would be expected. The consortium for SAT3 is charging other operators monopoly rates more or less equal to the cost of a satellite circuit.

A number of projects are under study for remedying this situation and it is very likely that the costs of international access will be reduced over the next few years. More and more countries in Africa are granting the mobile operators gateway licenses in line with requirements by the World Trade Organization for improved liberalization of telecommunications. This will increase competition and create possibilities for consortia to be formed for the construction of additional fibre cables to Europe.

In order to assess the cost impact of this situation, we explored what would be the effect of international Internet access on the data traffic. An average cost in Africa of an E1 is around € 5000 per month. If we use a peak factor of 5 implying that only 20 percent of maximum capacity would be utilized on average, the cost of international access would be 4 € cents per MB. This is a significant cost and we included this in our simulation model.

We would like to emphasize that the availability of reliable access to the Internet sites at adequate speeds is far more important than the underlying cost factor. We are dealing with the most powerful traffic generators in the region in the form of mobile voice traffic. Most of the mobile operators already transmit this voice traffic over IP circuits. Therefore adding a few E1 channels to accommodate data is an incremental cost only and will be obtained at the lowest rates available in the country.

Domestic Transmission Capacity

The general inadequacy of telecom infrastructure coupled with the phenomenal growth of mobile telephony, has resulted in the leading mobile operators having constructed their own backbone microwave networks. Surprisingly, this applies also to mobile operators owned by the incumbents.

This places the mobile operators in a very favourable position for providing Internet access on their GSM networks. Their cost base for the transmission is marginal costs. Our simulation model shows that the load of the data traffic on the transmission capacity is only a few percent of the voice traffic.

If competing operators would like to offer Internet services on a countrywide basis using the mobile operators' transmission network for the backhaul, this would under present regulation not be allowed in most countries. The reason is that the incumbent fixed line operators still have a monopoly on transmission. When they failed to service the mobile sector, the regulators granted the mobile operators an exception for providing transmission facilities for their own use in order not to hamper mobile development. This situation essentially blocks any alternative technology to enter the Internet market on a large scale.

Availability of Frequency Spectrum

GPRS and EDGE use the same frequency spectrum as the GSM network on which it is overlaid. However successful these data services would become, there would be no frequency spectrum problems in accommodating the data traffic. This would be the case even in densely populated urban areas. Voice traffic will remain the main traffic generator and cells might need to be made smaller due to increased voice traffic intensity, but not due to data traffic.

Compression Technologies

The data rates on GPRS have been considered too slow in mature mobile markets for certain applications and for general web browsing. A few companies have therefore developed wireless data optimisation technology for performance enhancements on GPRS. We have interviewed one such supplier and concluded that the costs of such systems are too high for the African environment. It is far more cost effective for the operators to upgrade the network to EDGE, which would have a superior data transmission rate and customer percep-

tion than the data optimization products.

Billing Systems

If a GPRS upgrade is relatively straight forward as regards the GSM network, the billing issues would be far more complex to address. When GSM started in Africa, many operators selected prepaid schemes that cannot handle billing of data traffic. However, the rapid growth means that most operators are starting to outgrow their initial billing systems and need to replace them. The median size of the operators in Sub-Saharan Africa was about 150,000 subscribers at the end of 2004. This size more or less corresponds to the threshold level for introducing an Intelligent Network node, which is financially viable for other reasons than charging efficiency. It is the best solution for pre-paid roaming that needs CAMEL 2 functionality in the network. If the network has IN nodes, the GPRS billing can be achieved at costs that are reasonable even for limited data volumes.

In other words, it would make a lot of sense to introduce modern convergent billing in connection with IN node deployment. All modern convergent billing system can handle a variety of charging schemes for data traffic in real time, for post-paid as well as prepaid customers. Our investigation shows that there are hybrid solutions that would enable data charging for GPRS also in cases when the operators do not want to change their billing environment. One such example is shown in Fig 9.

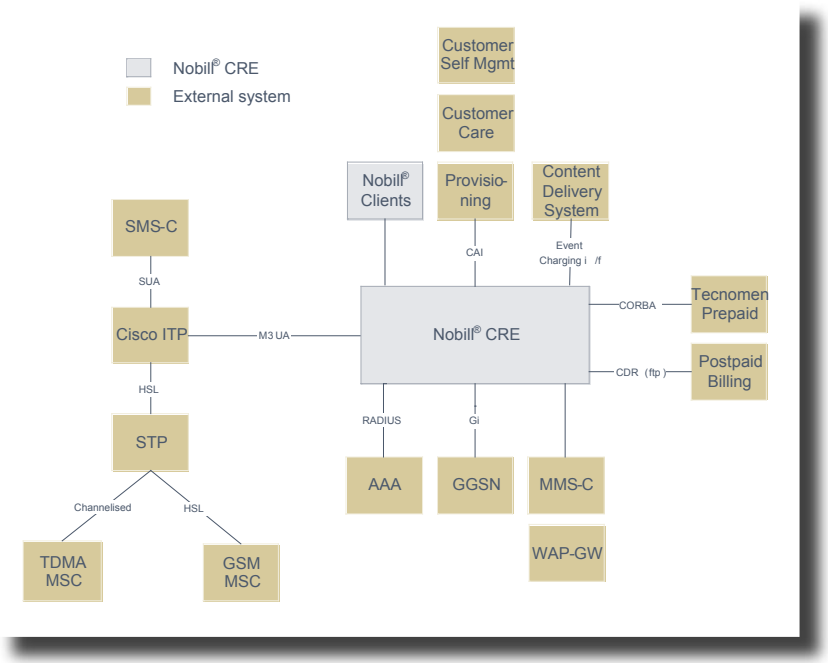

Fig 9. Source: Symsoft AB

Throughout this study, we have been taking a marginal cost approach for all GPRS related costs. This is particularly important when it comes to billing system upgrade. Modern convergent billing systems are very complex systems with very high capability and broad functionality. Since they handle billing information is real time, involving large amounts of money, the availability and security requirements are very stringent. The costs of replacing existing post-paid and pre-paid billing systems is consequently high. The GPRS billing feature is a standard component of convergent billing systems and represents only a fraction of the total features offered.

Based upon our discussions with billing suppliers, equipment vendors and operators, we have arrived at € 200,000 as the marginal CAPEX cost for GPRS billing. This amount was arrived at in consideration of the small number of GPRS subscribers and the low volume of data traffic.

Operating Costs

The additional operating costs for GPRS/EDGE services consist mainly of software licences and leased line rentals. Some vendors charge a fee per new subscriber instead of letting the operator bear the whole initial upgrade costs. We have preferred to show the actual CAPEX outlays in the initial years in our model in order to avoid having too many parameters. The marginal network costs will be low in the short run, but the organisation needs to be reinforced with marketing and support staff for data services. The connectivity cost depends on the data throughput and the prices for fixed lines in each country as well as the costs of international channels. As mentioned above, these costs are handled separately in our model.

Summary Operator Investments

The various cost factors have been incorporated in our simulation model. Since we are studying relatively small networks, the initial costs of the central nodes in the networks become significant start-up costs and the marginal costs for adding new GPRS users are very small. In our simulations the investment cost per GPRS customer varied between € 100 to € 320 (including billing and RBS software license costs). Considering that the whole network would become GPRS enabled, this must be regarded as a very modest investment. The major investment for getting the GPRS service will, however, have to be borne by the customer. In the case of the customer, such investments are presently expensive and major.

Subscriber Investments

We shall now look at the investments the customers have to make in order to become users. We shall ignore the existing PCs and other IT equipment, assuming the users have already incurred the costs for acquiring them. On the other hand, their number is so small that it will not suffice for justifying the GPRS investments and new terminals are needed for the market to take off.

As is commonly the case for GSM handsets in Africa, we have also assumed that the customer will be paying the full cost of the GPRS terminals. There are no subsidies in our estimates.

As we saw in the data from ITU, (table 1) the number of Internet customers is very small compared with mobile subscribers. Customers interested in an Internet connection in Africa belong to a better-off minority, and have far better than average financial resources. Because of this, the financial barriers for future customers may not be as serious as they seem.

Handsets

Any GPRS enabled cell phone can be used as a "modem" to connect the user's PC to the Internet. Since our assumption is that EDGE will come as a later upgrade after several years, we do not have to consider the availability or capacity of EDGE terminals. Most new terminals now sold in Africa have GPRS functionality, and we estimate that they will cost from €75 per user and upwards.

An issue is whether a GPRS phone alone would suffice for using GPRS services. Would the customers be interested in paying for GPRS services by only having access to WAP content, rudimentary e-mail services and various limited content provision? At present, this seems very unlikely unless some ISP's or content providers invent some highly valuable content services.

Dedicated Data Terminals

For new Internet users in Africa, the cost of a PC is often a big barrier. A simple PC costs several monthly salaries for a mid-level office worker, teacher etc. For Internet, and especially email use to become popular, other solutions are needed. It is possible to send and receive emails with a regular GPRS phone, but it is not a user-friendly solution. The Blackberry solution is better with it's mini-email solution built into the device. That makes it easy to use, but the price (€460)[10] is too high for an African mass market. Nokia's Communicator 9000 series is another solution, with functionality more like a PC, but even its price (€500-700) makes it unattractive for Africa. Nokia offer one model with a folding keyboard as an accessory, but for the African market, cheaper solutions are probably needed.

10 Retail offer in Stockholm Sept 2005.

PCs for Emerging Markets

PC prices are steadily declining. Dell's best US offer in September 2005 was a desktop for €450 and a notebook for €600. Apple Mini is sold for €400. It should be remembered that prices in Africa are considerably higher due to import duties, VAT and high dealer margins.

The GSMA's initiative for obtaining low-cost GSM phones has resulted in specially designed phones for the emerging markets. A similar initiative has been taken by MIT Media Lab in the US aiming at getting low-cost PCs for these markets. These PCs would be ideal for the GPRS services.

The MIT Media Lab's initiative "The $100 Laptop" aims at providing schools and children in developing countries with a low cost personal computer[11]. If this initiative materialises on a large scale, some developing countries could see a strong increase in the number of Internet devices available.

11 See http://laptop.media.mit.edu/

The specifications for the MIT device do not include any built-in GPRS functionality for providing Internet connectivity at the terminal level. Instead, a cluster of computers will self-configure into a wireless network and connection to an Internet backbone will have to be arranged by other means. There are already routers for WiFi to 3G/GSM connection[12] on the market, which could be very feasible for connecting e.g. schools to the Internet.

Ease of Use Issues

Configuring an Internet connection via a dial-up line is normally very simple, using the built-in plug-and-play functionality of modern operating systems. Configuring a mobile phone to connect via GPRS is far more complicated, since there is no direct support for it in the operating systems. Even if most terminals can be autoconfigured by the operator over the air interface, setting up the terminal as a modem to a computer is still very tricky. Especially Bluetooth connections are fail prone and unreliable. In the interest of reduced support costs, a number of things must be made right. The African Internet customers will in most cases be IT novices, and anything but a full self-configuring setup process will be asking for trouble. Good information services about use and costs will also be needed. There is a high penalty to pay in terms of missed revenues, for those who ignore the ease-of-use aspects.

12 See e.g. www.novatel-wireless.com

Summary Subscriber Investments

We have shown in this report that upgrading a GSM network to GPRS/EDGE functionality would enable offering Internet services to everybody having GSM coverage. Since the corresponding investments for the operators are small, our simulations show that it will be profitable even at low customer penetrations.

However, at present price levels for GPRS terminals suitable for Internet services, it will not become a mass market. For GPRS services to take off, new low-cost terminals are required. Fortunately, we see increased attention to this area by some suppliers. For example, both Ericsson and Nokia have announced push-mail solutions to compete with Blackberry. In addition, the mobile phone suppliers have completely taken over the PDA market with their smart phones. Considering the very high GSM growth in emerging markets, we believe they will soon start to address also the need for low-cost data terminals for these markets.

Cost Benefit Analysis

The conditions on the ground vary a great deal between African GSM operators. Countries differ in size from one to 140 million inhabitants, the number of customers vary from 30,000 to 10 million, the economic and politically situations vary from established democracies to failed states, and the maturity of the market varies greatly between countries. These differences set the conditions for action by individual operators, for example with regard to the introduction of GPRS services. There are also differences in the operator strategies, where some operators invest in ambitious coverage expansion, while others concentrate on niche markets in cities. Because of all these variations, there is not just one way to look at GPRS introduction, but as many ways as there are operators. In order to allow for the diversity, we shall present three scenarios, and we shall use our simulation model to create a cost-benefit analysis for each.

The three scenarios will reflect three different market conditions, reflecting Internet markets of varying size and maturity. The model is based on the situation in Tanzania, where we have estimated the number of companies and institutions of different type and sizes in the country, and added an estimated number of private users that may become customers. The scenarios will reflect different competitive situations, as well as variations in CAPEX and operating costs. We have designed three scenarios that would be representative for Africa. We have applied the model to one country with approximately 30 million inhabitants, for an operator with one million GSM customers in the first year, and two examples for a smaller country, with nine million inhabitants and with an operator size of 400,000 customers.

In each case, we have assumed that the operator network is a standard GSM network, and that no physical installations are needed on the cell/TRX level. The only necessary hardware upgrades are the GPRS nodes and the billing system.

The three scenarios are run through our simulation model for five years, using a dynamic set of input parameters, reflecting assumptions of market shares, prices and costs. The input parameters are given in table 4.

Input parameters					
Market shares	**2006**	**2007**	**2008**	**2009**	**2010**
Sc. 1: Large country, 3 Op:s	5	10	15	20	25
Sc. 2: Small country, 2 Op	10	15	20	25	30
Sc. 3: Small country, 3 Op.	5	10	13	15	18
Cost per E1					
Sc. 1: Large country, 3 0p	8000	7000	6000	5000	4000
Sc. 2: Small country, 2 Op	8000	7000	6000	5000	4000
Sc. 3: Small country, 3 Op.	8000	7000	6000	5000	4000
GPRS prices					
Sc. 1: Large country, 3 Op	0,20	0,20	0,20	0,15	0,15
Sc. 2: Small country, 2 Op	0,30	0,25	0,25	0,25	0,20
Sc. 3: Small country, 3 Op.	0,20	0,20	0,18	0,15	0,13
The market base has been kept constant over time, but a gradual increase in the number of MB per user over time is applied.					

Table 4. Input to simulation.

The size of the GSM operators will to a large extent determine the profitability of a GPRS investment. The GPRS upgrade requires the installation of central GPRS nodes at a fixed cost. The investment is about the same for large and small networks, giving advantages to the larger operators.

In all the scenarios, we have used a very low penetration of Internet users in order to be conservative and take into account the high customer costs for terminals. We have estimated an initial market demand corresponding to a 3 percent penetration, which is then shared among all the operators.

Scenario 1 – Large country, strong competition with fixed operator alternatives.

In this scenario, Internet services are already well established through the existing fixed network. Most existing customers are using dial-up connections of variable quality, paying an average of €20 - €30 per month for the connection. There are some DSL connections, but ISP:s are offering wireless connections with up to 128 kbps, at a price of €200-€400 per month. Leased lines are available through the incumbent, but at extremely high cost. There are also some private VSAT solutions used by some international companies and institutions. The cost for these is also very high, in the region €2000 for a 256 kbps connection. We expect our GPRS services to meet the needs of some new customers, and to be an attractive substitute for many dial-up users. The market share is expected to start at a modest level, increasing together with a general increase in the size of the market.

This scenario is the strongest one in or analysis. It shows very high profitability for a large operator in a relatively large country, even though we assumed equal market share between three mobile operators.

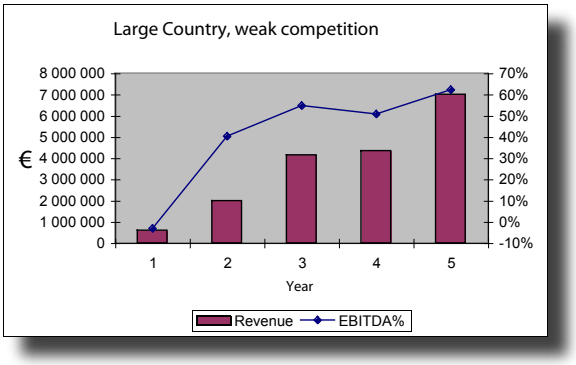

Fig 10.

Scenario 2 – Small country, green field, weak competition

For a smaller country we assume that the fixed line infrastructure is poorly developed. As a result, there are relatively few Internet users to begin with, but we assume there is a large pent-up demand. Existing users of the few available dial-up lines experience poor quality, or they are connected to various expensive VSAT based wireless solutions. We expect our GPRS solution to be delivered at relatively low prices, and that it will attract a large market share.

In market conditions like this, the operator will get a satisfactory return on their investment in GPRS capacity. Small operators in small countries will be profitable in the second year of operations.

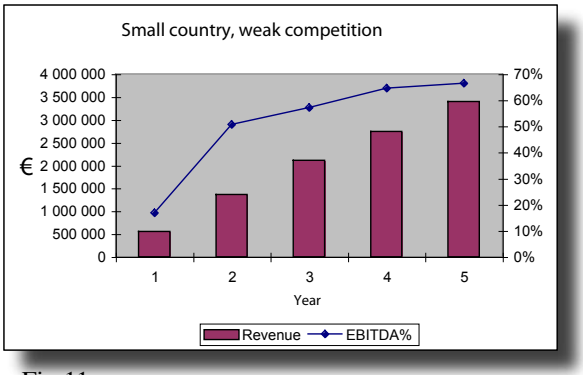

Fig 11.

Scenario 3 – Small country, green field, strong competition

This case is similar to the above, but the country has a relatively good fixed network and many Internet users. There are also other mobile operators offering GPRS services, as well as various other connectivity solutions. This affects the market share, and prices are assumed to be lower than in other markets. The result is lower results than in the other scenarios, but EBITDA % is positive from the second year and the overall return on the GPRS investments would be satisfactory.

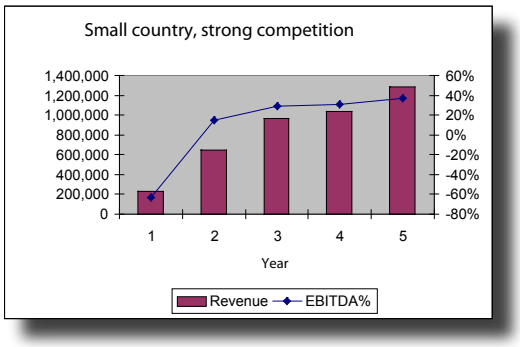

Fig 12.

Simulation Results

We have run a number of simulations in addition to the three scenarios described above. They all show surprisingly good profitability is spite of our low penetration assumptions. In all simulations, the revenues generated from data services will continue to be small when compared with voice revenues; in no case has the number of GPRS customers exceeded one percent of the regular voice customers.

Our conclusion from the analysis is that not only will GPRS investments be very profitable, but also there is a very strong upside for the operator that would manage to capture a substantial market share and thus get better than average penetration.

Implementation Issues

Other Data Based Services

GSM operators in Africa offer a unique customer value – 80% or more of all telephone users are connected *only* to a mobile network. This near universal access potential is a massive market advantage, locking out all telecom competitors in low-density areas. In addition to Internet access, GPRS/EDGE enables the delivery of new IP based services in the network, with revenue opportunities from new market segments. There are especially two new services made possible by IP technology – Push-to-Talk and Audio messages – that might have a revenue potential exceeding the Internet use of our study. They are extensions of voice services, but offering great cost advantages in the network by using GPRS/EDGE as a bearer. The appeal of these services in Europe may be small, but Africa is different. Fewer people in Africa have the necessary literacy to communicate in writing, which may explain why SMS services are used less than elsewhere. Push-to-Talk and audio messages connect to African oral cultures, and both have great potential as complementary products besides regular voice. They are both half duplex services, and therefore easy to differentiate as separate products. Offering them at a lower fee to price sensitive customers will reach into a new market segment, increasing revenues with lower system loads. The result is improved overall capacity utilisation and higher operating margins.

The study of Push-to-Talk and voice messages is beyond the scope of our investigation. We would just like to point out their strong potential and that once they are rolled out, they will improve our business case for GPRS/EDGE upgrades.

ISP or Access Provider

If a mobile operator is to provide Internet services to clients, there will be implications for its regular business model. There are two options: To become a full service ISP company, or to resell network capacity (with or without international bandwidth) to other ISPs. We will briefly discuss these two cases.

If the mobile operator enters the market as a new full service ISP, it will be in competition with the existing ISPs. They would have little incentive to bring Internet services to new areas via the GPRS network. In order to capture the new customers, the operator would therefore have to build a new sales and services organization for the Internet customers. A new business area will distract attention from the operator's core business. It will also increase the CAPEX of GPRS introduction, and may be difficult to justify. Some mobile operators have experienced that it was not a good idea to add a new ISP business line to a successful GSM operation. However, the most important disadvantage is that the operator has to work against the other ISPs, rather than using them to sign up customers for GPRS connectivity.

Internet services are already established in all countries through incumbent owned or private ISPs. The market is starting to take off and both large and small ISP companies are established in each country. Provision of GPRS/EDGE will spread the access to medium capacity data services to new areas and new customer groups. This would provide a potentially large new market for all ISPs. In this context, it is important to separate connectivity and Internet services, and to look at them as separate services. The revenue potential lies in the GSM operator's control of connectivity and transmission facilities, not in the service of email or Internet services. He wants to sell GPRS data traffic over the GSM network. In case the operator decides not to engage directly in ISP business in a country, it can provide network services to ISPs. One option would be to let the ISP's be the primary sales channel for the GPRS services. The operator could sell network access wholesale to each ISP, charging per network usage or per connection, or alternatively only let the ISP handle the sale of the subscription on the operator's behalf. The key benefit of this alternative is that all ISPs will then promote Internet access over GPRS. Since the alternatives for access are limited, they would all get the opportunity of increasing the market. This will increase the technical competence close to the customers and this would be needed to assist the customers in getting GPRS

configured.

Which solution an operator should choose depends of course on local conditions. There are countries where the incumbent also runs the dominant ISP in the country. In such a case, it may be a little difficult to persuade this ISP to sell GPRS connectivity to existing dial-up customers. A possible strategy is then to partner with another local ISP, opening their services to new customer groups.

Regulatory Issues

ISPs typically do not own extensive transmission facilities and instead rely upon lines leased from underlying network providers. The economic barriers to entry into the ISP market are low, and robust competition is possible even in smaller geographic markets. Consequently, some countries have established open entry policies for ISPs. New providers do not need to obtain individual licences or other formal approvals from the government before entering the market; nor do they even have to notify the regulator before beginning operation. Other countries require notification, but not before operations begin. Several countries in Africa still have restrictive licensing and high fees. Teething problems have emerged in two areas: mobile portals and ISP licensing for mobile operators. There is no apparent consensus on whether a mobile operator needs a separate ISP licence to provide Internet access over its mobile network. Of course, this is not an issue in countries where ISPs generally can operate without a licence. In other countries, this has been a stumbling block to the introduction of mobile Internet services. In St. Lucia, mobile operators were required to provide their mobile Internet services for free until they obtained an ISP licence.[13]

Key Success Factors

Scanbi Invest visited the two operators in Sub-Saharan Africa that have implemented GPRS services, namely MTN in Uganda and Safaricom in Kenya.

From our discussions, it seems clear that they have not made a full-hearted launch of the GPRS services. The marketing and distribution factors have not been addressed. The result is that the customers are having difficulties in configuring the GPRS services and even the ISPs interviewed were having similar difficulties.

Our analysis point at good profitability for the GPRS services even if poorly marketed and distributed. There are enough customers that have no alternative for Internet access, who will eventually get connected. At least as long as the initial African price levels are maintained.

We would like to point out that eventually the African mobile market will become saturated and growth taper off. It should, therefore, be highly desirable for the African operators to start planning for the future and already now aggressively address the great business opportunity of GPRS/EDGE services.

We would strongly recommend that partnerships with the ISP's be arranged, whereby the ISP's take the responsibility for distributing the GPRS kits, including configuration services. Present distribution channels for pre-paid cards are not appropriate for advanced data services. The ISP's should be compensated for their services by getting a good margin on the traffic generated. This will ensure that they will very actively promote the GPRS based Internet access. We would estimate that and efficient distribution channel for the GPRS services would most likely double the operator's number of GPRS customers. This would make the GPRS investment as profitable as present voice services and with a great potential for future growth.

13 Quotes from ITU: Trends in telecommunication reform 2004/2005, and Scott Wallsten, Regulation and Internet Use in Developing Countries. Brookings Centre for Regulatory Studies. 2003.

Conclusion

Privately financed GSM operators in Sub-Saharan Africa have in a few years created a completely new telecom infrastructure with a capacity far greater than what the state owned telecom authorities have provided in 100 years. More than 100 operators are active in the continent, most with great financial success. Expectations of future growth in subscribers and revenues continue to mobilise investment capital for expansion.

At the same time, Internet access is lagging behind, and most African nations are far behind in their use of ICT. Access is limited to the inadequate fixed networks or expensive VSAT connections, restricting Internet access to the traditional economic centres. The new GSM networks have wider area coverage, and the built-in GPRS/EDGE standard can provide wireless data services wherever the GSM networks reach. Data services can become an important future revenue source for a GSM operator. So far, only a few operators in Africa have implemented GPRS and started to sell data services. For the remaining ones, there is a question about the business case for GPRS and EDGE. All operators know that the number of GPRS customers will only be a fraction of the voice subscribers, and that the revenue base for data services is rather small. Introducing GPRS services require additional investments that may compete for management's attention with further investments in coverage, in order to meet sometimes-aggressive competitors.

We have shown in this report that GPRS services are profitable even for small operators. There are therefore very strong reasons for starting to address this market in order to ensure that revenue growth continues even after the growth in the voice market has been tapering off. In addition, there is a strong upside in profitability for those operators that can secure a good market share by addressing the difficult distribution issues. The process towards GPRS has started and it is in the interest of all operators to work out their own business cases based on their own special conditions.

This report can also help African Governments to realize that there is a new opportunity to get Internet services to a very large percentage of their population. Many national ICT plans exist, but very few of them have taken the GPRS opportunity into account. How many Government officials in Africa realize that it is technically and financially feasible to equip all secondary schools with Internet access via GPRS? No other technical alternatives exist that would be as cost efficient.

Annex 1: Study Area and Simulation Model

Our basic assumption is that GPRS/EDGE services would be offered to subscribers in a typical African environment. We have studied the Arusha/Kilimanjaro area in Tanzania, with approximately 1.5 million inhabitants covered by GSM services in the area shown in the map in fig 13..

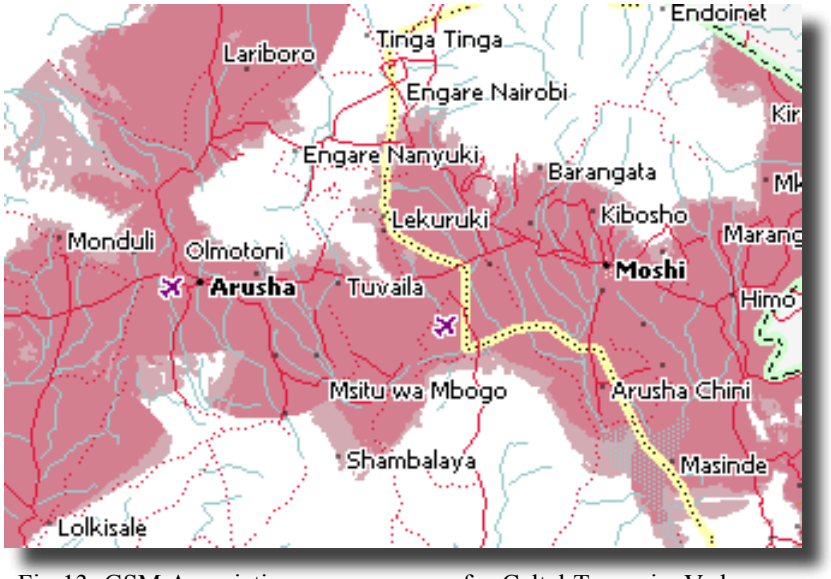

Fig 13. GSM Association coverage map for Celtel Tanzania. Vodacom and Mobitel have similar coverage in the area. www.gsmworld.com

The population in the area is about 6% of Tanzania's population, but the concentration of mobile users is assumed to be higher here than the average of the country. We assume that there may be about 200,000 mobile users in the area, which would give a penetration of 12 percent. The number of fixed lines in the area is estimated at around 15,000, and the number of current Internet users may be a few thousand.

The key question for an operator when investing in GPRS/EDGE services is the number of potential users, and their use patterns. The revenue stream must cover operating costs and investments in an acceptable time frame. We have therefore designed the simulation model to enable us to test different assumptions. The market is divided into the customer classes described above. For each customer class a number of users per unit is determined, and an assumption of the monthly data volume in MB. These assumptions are the basis for our revenue calculations. Local market conditions will determine the actual number of users, the market share and the prices, but the bottom line is to show an acceptable cash flow.

The model deals only with ordinary Internet services. Elsewhere in this report we discuss new IP based voice services as potential revenue generators in GPRS/EDGE enabled networks.

The initial input data for the above area are as follows:

The numbers in the table have been derived from an analysis of TTCL's telephone directory for Arusha and Kilimanjaro. The numbers for users per company are our estimates, as well as the assumptions about monthly MB usage. The last row has an assumption about visiting (foreign) GPRS roamers. In the example above 50 roamers per month is assumed, each using 5 MB of data transfer during their stay. These customers will be an important revenue generator, since they are charged a considerably higher price per MB

Basic data - Customers	Number	Users/inst	MB/month
Larger institutions			
Internat inst & NGOs	500	5	150
Government of TZ	300	3	150
Higher Education	50	20	300
Large business	400	10	200
Smaller customers			
Medium business	2500	1,5	150
Local Govt	100	10	50
Education (Schoolnet)	70	10	50
Private	60000	1	50
Incoming roaming	300	MB per pers.	5

than the normal users[14]. Arusha has a large number of visiting tourists and business people, many of who will choose a convenient wireless connection rather than visiting an Internet café.

The simulation model has another set of inputs through which prices, growth and market shares can be varied, and where revenues and costs can be calculated for any future year. The peak rate is used to calculate the bandwidth requirement from data usage (similar to busy hour for voice traffic).

The third input group deals with investments and costs. Since there may be a fixed upgrade cost per cell unit, the number of cells in the network must be known. Other additional investments can be entered under the heading Central Capex, as well as the depreciation period. An annual operating cost item is also included.

Based on all these inputs, the simulation model calculates the amount of Mbytes throughput for a year, and presents a table with revenues and costs. The model is developed as a standard Excel worksheet.

Market and capacity	
Year	2005
Growth perc.	5%
Revenues from data services (bandw only)	
Market share	5%
Fixed rate per month per user	22
€ per MB	0,2
Education discount	60%
Roaming price €	4
Peak ratio	5

Investments and costs	
No. RBS	700
Upgrade cost/BTS	1 000
Central CAPEX	800 000
CAPEX	1 500 000
Years PB	5
Depr	300 000
Op cost	100 000

14 Roaming voice revenues for a typical African GSM operator is around 10% of total revenues. European visitors generate almost all these revenues, since roaming by local customers is negligible. It is therefore assumed that a similar pattern will be found for data roaming.