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Roaming in Africa

Ewan Sutherland ‡

Introduction

As cellular wireless services using GSM technology have spread through Africa with it has come the possibility of international mobile roaming, that is the capability to take a handset and SIM card from one country to another and to obtain service there. Such calls, text messages and other services are paid to the home operator, whether on subscription or by reduction of pre-paid credit. The level of charges for this service are generally very high, several times the costs, generating concerns and complaints by users (Sutherland, 2000).

When customers select between operators and tariff plans they tend to focus on the handset and the price of calls or, in the USA, the size of the "bucket" of minutes. They seldom enquire about the cost to another person to call them or the cost of international roaming charges. Bundling international mobile roaming with access, origination and termination of calls allows the operators to protect it from competitive pressures.

A further complication both commercially and for any regulatory intervention is that the wholesale and retail markets are in different countries. A retail customer in the USA buys a cellular service then roams to Africa where the home operator has contracted with a local operator to provide service. There is an exchange at the wholesale level of the capability to roam and also of customer traffic.

Roaming was originally only for subscribers and limited to a single technology. It has gradually been extended to different technologies and to pre-paid customers. It spread rapidly as operators realised it was a means to attract and to retain high-spending customers for outbound roaming and an easy way to generate revenues from inbound roamers.

Alternatives do exist, notably plastic roaming, where the user changes the SIM card. There is also the possibility of satellite services, especially in remote areas. There are the beginnings of an alternative in Voice over Internet Protocol with fixed and wireless broadband access. Another possibility is Pre-paid Local Number (PLN) in which the visiting pre-paid customer is assigned an additional number, a second IMSI, but on the existing SIM card and with new credit. It allows the continued use of stored numbers and is less disruptive than plastic roaming. It can be less costly than traditional roaming for the customer, but lacks transparency on the pricing. An example is the 'Ahlan' service of Etisalat in the UAE. It costs AED 90 (about US$ 25) and can be

‡ http://www.3wan.net/

topped up if needed, though it comes with 90 minutes of national calls, 9 text messages and a free three-minute call to any foreign destination. It lasts for 90 days duration but cannot be renewed.

For an operator in a developing country roaming can be a very attractive service. The inbound traffic generated by tourists, business travellers and government official can be considerable. Even in war zones, there will be people visiting the airport and the government offices, making roaming calls. These calls are paid by foreign operators in hard currency and require no marketing effort and negligible financial risk, when compared with domestic customers where there are high acquisition costs and unknown credit risks. Iraq and Afghanistan are examples of countries where the operators chose GSM over other technologies in order to obtain the revenues from roaming.

Africa now has a number of geographically extensive groups, covering a wide range of countries with the potential to offer pan-African tariffs. The groups include: MTC/Celtel, MTN, Orascom and Vodafone/Vodacom.

Historians and political scientists have commented on the somewhat arbitrary boundaries imposed on Africa by the colonial powers. These often ignore language and cultural groupings which may straddle a line drawn on a map by someone in London or Berlin. One consequence of this is that people quite naturally cross borders and seek to roam with their GSM handsets.

There are ancient patterns on nomadism in Africa developed as a solution to a shortage of resources. Indeed, this is likely to be part of the solution, with hot spots as oases of telecommunications.

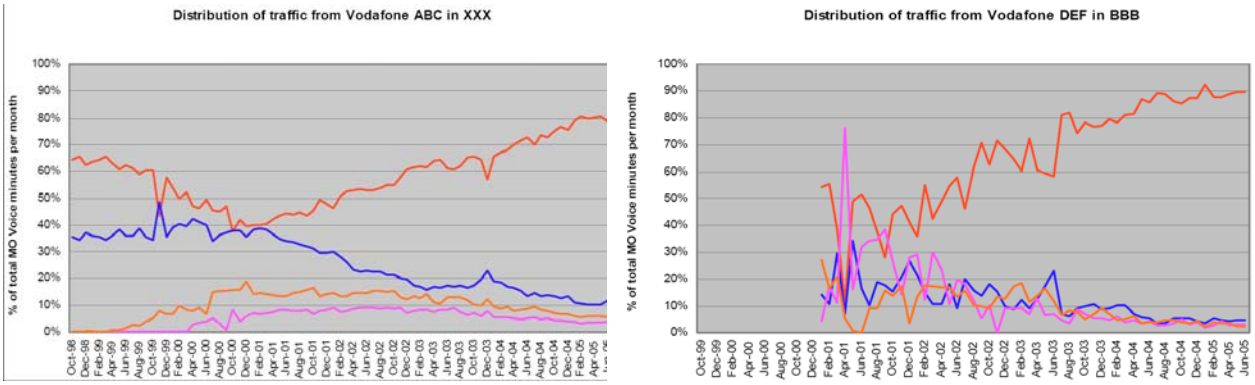
This paper describes the roles of international mobile roaming in Africa. There is a short technical explanation of roaming for voice and data, together with examples of the prices charged. Then the growth of mobile telecommunications in a variety of countries is explored. A brief analysis of the levels of competition in different markets. The economic benefits of mobile telecommunications of demand are discussed. A brief account is given of the developments in the European Union where efforts have been made to regulate roaming charges. Then some commercial developments from Hong Kong are described. The development of VoIP in Africa is briefly outlined, with an analysis of options for trans-national services. Finally, conclusions are drawn.

Roaming charges

In non-roaming usage, customer details are held on the Home Location Register (HLR). On arrival in a foreign country the Visitor Location Register (VLR) records details and determines from the HLR that the home operator will pay for any charges.

One of the changes in recent years has been that operators are able to direct traffic to specific foreign mobile operators. Originally, roaming traffic fell randomly on the different operators in a given country, give or take the efforts to strengthen signals around airports and other key locations in order to grab passing customers. With the data on the HLR, the operator can now send a message to the SIM card and cause it to disconnect from one operator and to connect to another, chosen by the home operator. This has been very effective, with as much as 90 or 95 per cent of traffic put on the network of the commercial partner (see figure 1). As a result the foreign operator has a considerable incentive to join or to make arrangements with the largest groups.

Figure 1 *Vodafone traffic direction* (Feasey, 2005)



Roaming was initially limited to post-paid customers and sometimes to those who had good credit records or had paid a special deposit. To expand the service it was necessary to include pre-paid customers which made it necessary to debit any charges from their stored credit, rather than to invoice after the event. This requires the development of a system known as Customised Applications for Mobile Network Enhanced Logic (CAMEL). It was to allow roaming subscribers access to a wide range of Intelligent Network (IN) services (Meskauskas, 1999). However, the deployment of these was to take longer than expected and required operators to make additional wholesale roaming contracts.

Table 1 *International mobile charges for US customers going from Cape to Cairo*

	Cingular standard	*Cingular world traveller*	*Sprint*	*T-mobile*	*Verizon global phone*
South Africa	2.49	1.69	1.50	1.49	2.49
Mozambique	3.49	3.49	1.50	1.99	1.29
Malawi	4.99	4.99	-	1.99	1.29
Tanzania	3.99	3.99	1.50	4.99	1.29
Kenya	3.49	3.49	1.50	4.99	4.99
Ethiopia	3.49	3.49	-	-	-
Sudan	3.49	3.49	-	-	-
Egypt	2.49	2.29	1.50	1.99	-

Sources: Cingular web site.[1] Sprint PCS website.[2] T-Mobile web site.[3] Verizon Wireless.[4]

[1] http://www.cingular.com/media/roaming_gen

[2] http://www1.sprintpcs.com/explore/ueContent.jsp?scTopic=internationalRoaming

For a customer from the USA going to Africa there are several challenges. If the handset is not GSM compatible, then it will be necessary to rent a handset, for example from IMC Worldcell. If the customer has a GSM handset with the correct 900 and 1800 MHz bands, then the next problem is that some operators have not signed contracts with operators in all African countries, so that the phone may not always work. For the countries where there are inter-operator contracts, the prices for someone travelling from the Cape of Good Hope to Cairo are shown in Table 1.

The pricing scheme adopted by operators in the USA is much simpler than in other countries, since there is only one price that applies per minute for inbound and outbound calls, regardless of destination. One reason for the simplicity may be to block customers from using calling cards. The cost of a call to a local point of presence of a US-based operator has been made by their rival US-based wireless operators the same as a call back to the USA. This is not the practice of operators in other countries and does not reflect underlying wholesale prices.

If a customer finds there is no local service then it is possible to engage in "plastic roaming", that is to purchase a pre-paid SIM card in the country. However, that requires that the handset is not SIM-locked. Discounted handsets are usually tied to the supplying operator for a period of time, after which they can be "unlocked", often for a fee. This is intended to allow the operator to recover the cross-subsidy on the handset. It can be a significant obstacle to plastic roaming.

Using a local SIM card will save money but creates the problem that the customer can no longer be reached on the home number, though a recorded message can be left with the new number. People often find these arrangements confusing and forget to set the messages, the call forwarding and the SIM cards correctly. They require simpler solutions.

Given the very high level of charges for customers in the USA it is very surprising that the public authorities have not acted. The wholesale roaming agreements violate Sherman Act §1 which offers the Department of Justice a means to address the problem. Alternatively a class action would appear feasible against those operators having a presence in the USA. While customers might not get much compensation from a class action it can be a very effective way to change the behaviour of corporations.

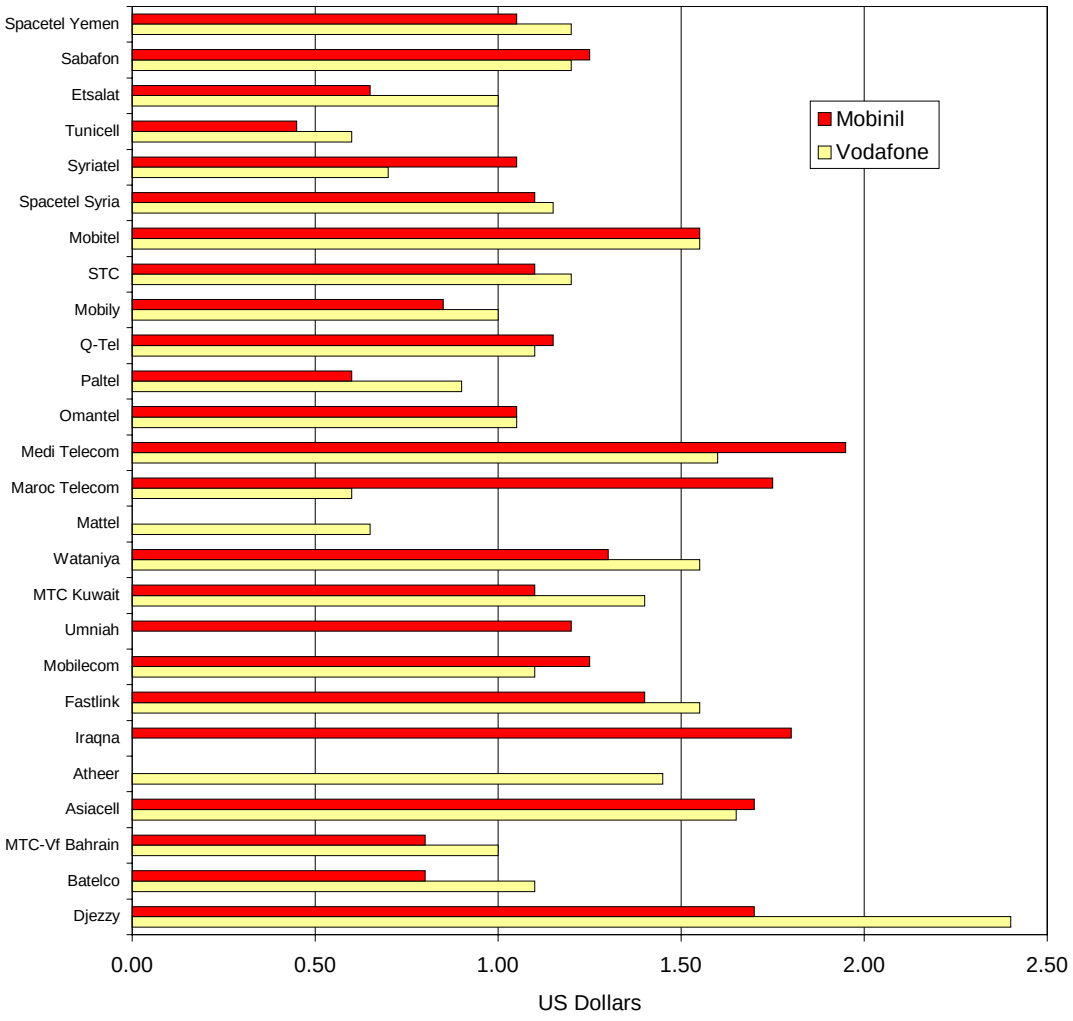
The Arab Regulators Network (ARN) took up the challenge of addressing high roaming charges in 2005. The Egyptian regulator coordinated data collection, presenting to its meeting of January 2006 detailed prices for roaming by operator and country. Figure 2 shows the prices charged for visitors to Egypt, by their home operator for both operators there: Mobinil and Vodafone Egypt.[5]

[3] http://www.t-mobile.com/International/RoamingOverview.aspx?tp=Inl_Tab_RoamWorldwide

[4] http://mobileoptions.vzw.com/international/global/region/africa.html

[5] A third operator has since received a licence and should be operational in 2007.

Figure 2 *Roaming charges for visitors to Egypt from other Arab countries*



The very wide range of prices and the seemingly arbitrary differences are typical of roaming charges. The seemingly inexplicable differences arise where operators set the tariffs as one very small part of a much larger bundle, with potential customers focused on a few basic indicators, usually the costs of calls to family and friends. The cost or the subsidy on the handset can also be a more important consideration.

Roaming services were initially offered within technology groups, primarily for NMT and then GSM. Gradually dual-mode GSM/NMT handsets appeared, with the necessary inter-network gateways. CDMA operators were slower to appreciate the attractions of roaming, but eventually dual-mode CDMA/GSM handsets were introduced, again with inter-network gateways. With UMTS, multi-mode handsets were essential even nationally, so that it was immediately available as GSM/UMTS for roaming.

For data roaming the operators have elected to create a Virtual Home Environment (VHE) for the customer for GPRS, EDGE, UMTS and HSDPA. The customer is, in effect, on a foreign extension of the home network with all its characteristics, even to the point that resolving a domain name into an IP address can be performed on the home network. This is achieved by the use of Virtual Private Networks (VPNs) linking the various networks to achieve high speed data traffic exchange.

The South African market is the most advanced in Africa in the use of mobile data services, both GPRS and UMTS. Indeed, operators have been very enthusiastic this year in marketing their HSDPA services for home use a DSL substitute and to business users with a data card for lap-top computers. It is therefore interesting to examine the cost of data roaming which is shown in Table 2 for selected countries. The prices, taking US$ 1 to be equivalent to ZAR 7, range from about US$ 1.80 per Megabyte with Vodacom partner networks in Southern Africa, up to US$ 20 in Australia and US$ 32 in Chile. In Hong Kong and Poland the price is heavily dependent on the network operator chosen, with some costing twice as much as others.

Table 2 *Data roaming prices for South African customers* (ZAR per Megabyte)

	Vodacom
Australia	88.95-138.99
Chile	223.68
DR Congo	12.50
Egypt	92.75
Finland	37.10
France	44.53-62.86
Germany	37.30-74.20
Hong Kong, SAR	49.73-99.45
Kenya	91.13
Mauritius	86.08
Namibia	62.50
Poland	56.24-100.55
Singapore	48.25-58.57
Spain	55.65-92.75
Tanzania	12.50
United Arab Emirates	84.00
United Kingdom	34.92-87.14
USA	45.19-57.31

Sources: MTN[6] and Vodacom[7] websites.

Vodacom also offers a "flat-rate" tariff service in conjunction with Vodafone in selected countries.[8] The charge on the partner network, but not on other networks in these countries, is

[6] http://www.mtn.co.za/?pid=237578

[7] http://www.vodacom.co.za/rcrch.do?action=get

[8] http://www.vodacom.co.za/services/roaming/flat_rate.jsp

ZAR 15 per Megabyte for GPRS and 3G roaming, charged in 10kilobyte increments. There is a separate rate of ZAR 150 per Megabyte for use of RIM Blackberry.

It is important to note that the Megabytes used for billing are not of user data. Although they exclude the GPRS or UMTS overhead, the "data" includes the TCP/IP overhead, so that the charges will be increased by from 30 to 150 per cent depending on the quality of the connection and the type of file.

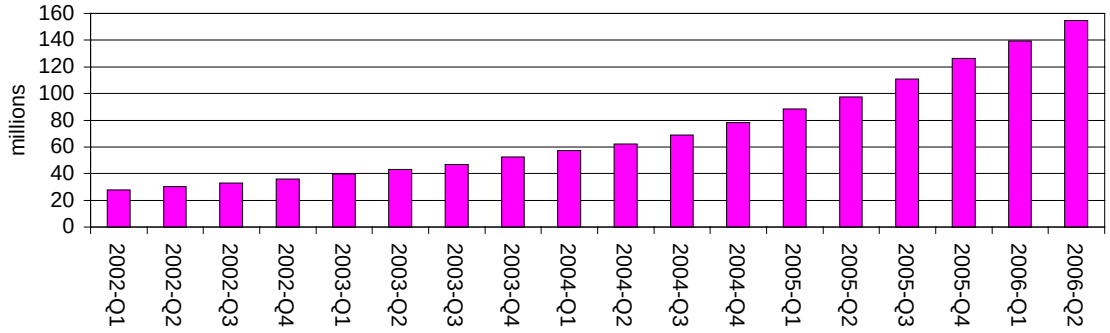
The BBC has recently reported that it has recorded significant WAP traffic for its news services from Africa, in particular from Nigeria. This is one of the first signs of the development of a market for mobile VAS in Africa.

Access to VAS raises complex regulatory issues when roaming. At least one African country bans the BBC and it might be unwise to access services there. There are also push services from the likes of Playboy, which offers a "babe" of the day, which would be considered unwelcome in many countries. A VHE may bypass the local content filters allowing access to forbidden material. There is also the matter that at the prices in Table 2 customers may prefer not to receive the latest sports video clip.

The growth of mobile telecommunications

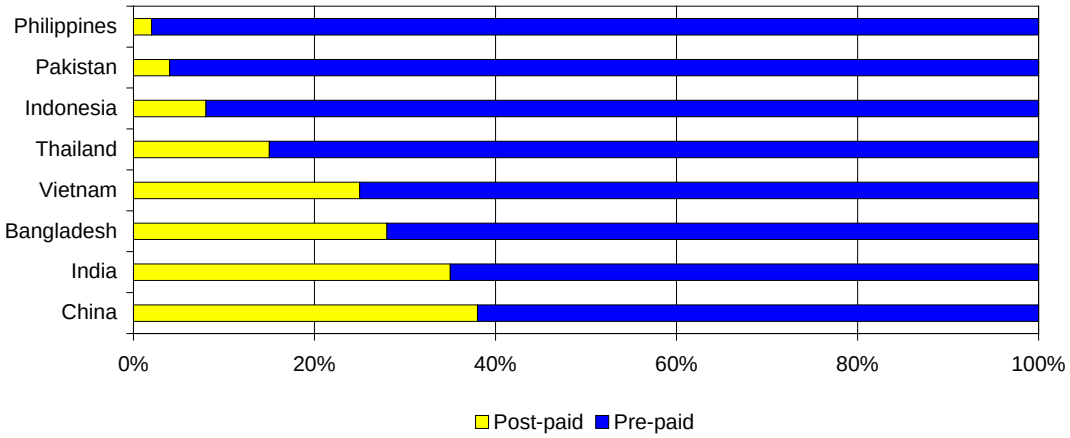
Recent years have seen remarkable growth in cellular wireless telecommunications in Africa, rising to almost 160 million reported customers or around 17 per cent mobile teledensity. This has been almost exclusively GSM (see figure 3), supplemented by very small amounts of CDMA and satellite telephony.

Figure 3 *Growth of GSM customers in Africa* (source: GSM Association)



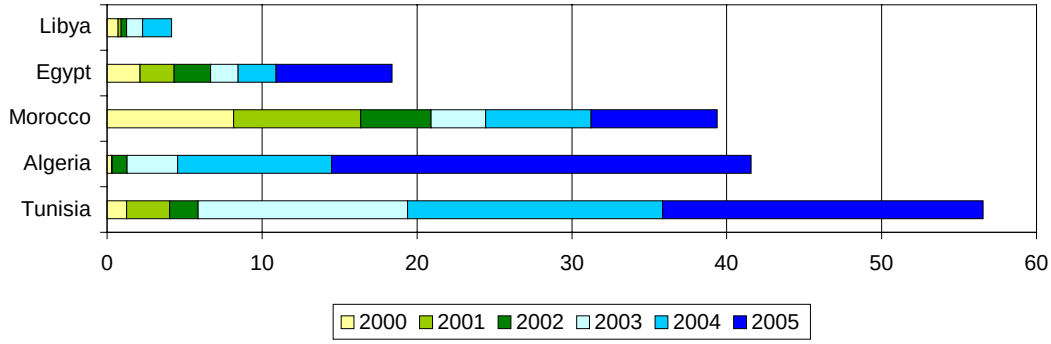
Overwhelming numbers of these customers are pre-paid, as is almost all of the recent growth. This reflects the low levels of income and the lack of cash. Moreover, the people concerned do not have experience of credit, nor do they have credit records that the operators might consult. It is a pattern common in developing and emerging markets (see figure 4).

Figure 4 *Other developing and emerging economies* [9]



In North Africa, there has been rapid and accelerating growth of mobile telephony as competition has made its mark (see figure 5). The introduction of second operators boosted growth and allowed cross-border market entry, for example, the Tunisian and Moroccan operators entered the Mauritanian market. With third operators having now been licensed in Egypt and Morocco growth can be expected to remain strong. Excluded from many technologies for over a decade, Libya is also beginning to catch up.

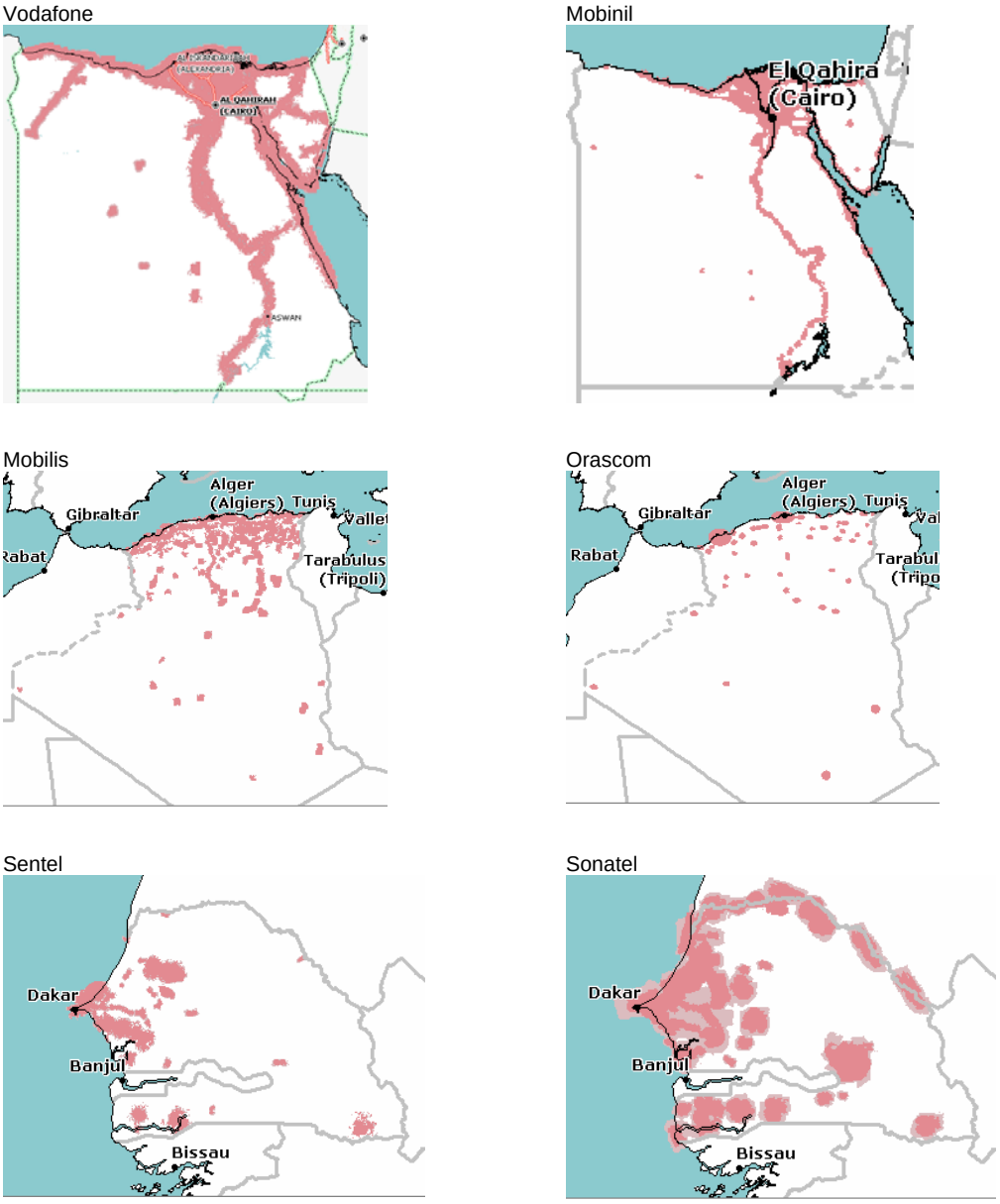
Figure 5 *Growth of mobile teledensity in North Africa* (source: ITU, 2006)



The growth of the customer base does not mean that there is complete national coverage, that usually begins in the capital and principal cities then is linked up on major routes. The extent of network varies greatly across Africa. Figure 6 shows the networks in Algeria, Egypt and Senegal, illustrating both the concentration on population centres and the different levels of the developments of the networks. Operators will make business judgements on the extent to which they cover a country, depending on the levels of competition and the market segments they consider most valuable.

[9] http://www.wcisdata.com/

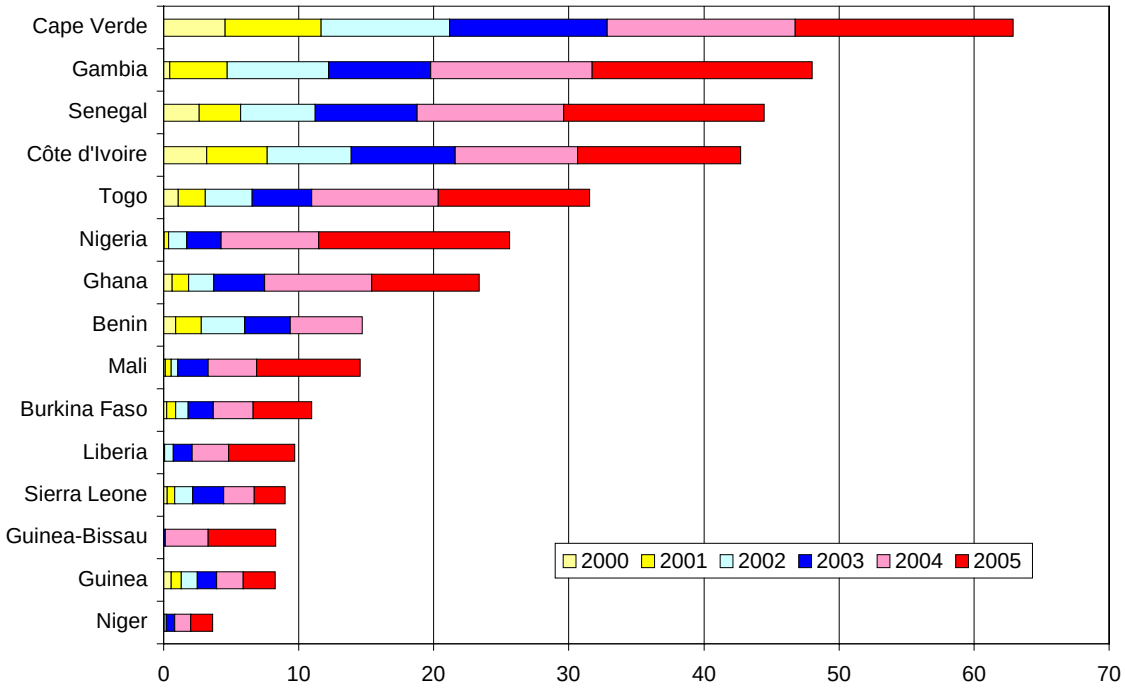
Figure 6 *Coverage in Egypt and Algeria* (Source: GSM Association)



For the roaming customer from abroad the differences in network coverage is irrelevant. A foreign handset will find any signal and allow access to the service. This is subject to two qualifications, the first that there is no price difference between the visited networks and the second that a contract exists between the operators. The latter can be a problem in Africa where multiple roaming partners are less common than in Europe and Asia.

In West Africa there has been rapid growth (see figure 7). A very wide range of mobile teledensities can be seen, though all show significant growth in 2004 and 2005.

Figure 7 *Growth of mobile teledensity in West Africa* (Source: ITU)



There is a special case of Small Island Developing States (SIDS) which have are invariably difficult markets to serve. Income levels are typically low and remoteness adds greatly to the costs of physical distribution. The African SIDS are shown in table 3. These can be divided for telecommunications between those with strong tourist sectors, that is Mauritius and the Seychelles, which helps to pay for network construction and those without tourism, the Comoros and São Tomé and Principe. These suffer greatly because of the small size of their markets and the lack of undersea cables, making it very difficult to provide services that are affordable to populations with very limited incomes. The Cape Verde Islands are a special case, because of their links with Portugal.

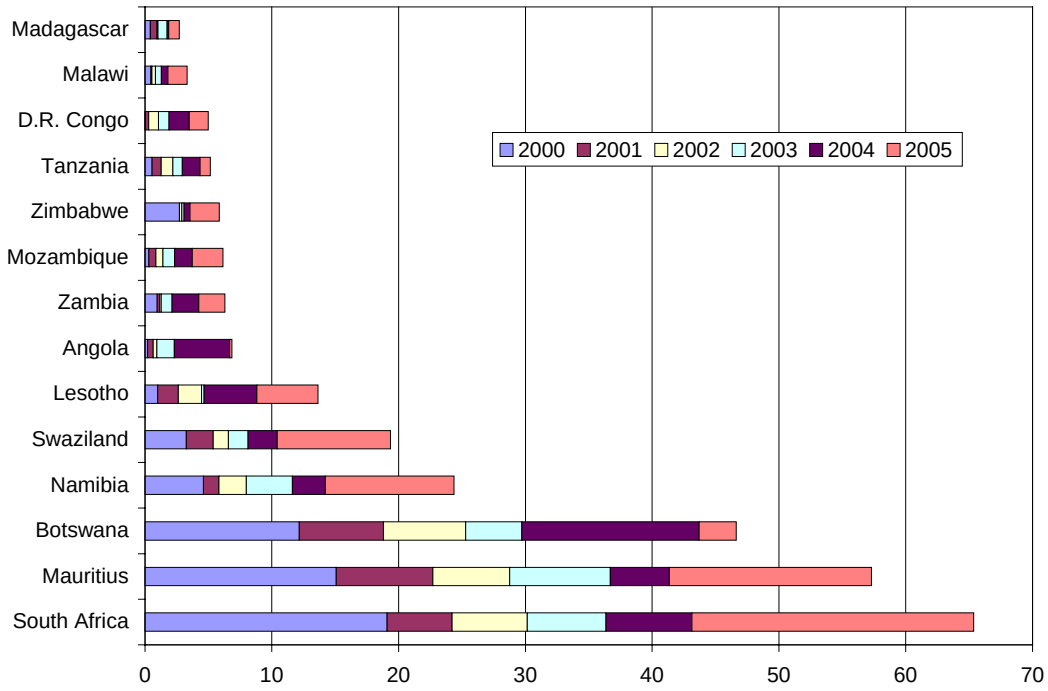
Table 3 *Small island developing states*

	population	*area (km²)*	*mobile teledensity*
Cape Verde Islands	415,294	4,033	16.1
Comoros Islands	651,901	2,235	2.0
Mauritius	1,220,481	2,040	57.3
São Tomé & Principe	181,565	964	7.6
Seychelles	80,832	455	70.4

Source: UN-OHRLLS and ITU.

The Southern Africa Development Community (SADC) shows a significant split in mobile telecommunications between three leaders, three followers and a long tail of poorer performers (see figure 8). As with West Africa, 2005 was a good year, showing significant growth.

Figure 8 *Growth of mobile teledensity in Southern Africa* (source: ITU)



By comparison there has been only limited growth of fixed networks and in a few cases the collapse of the fixed network operator.

Some commentators write about mobile "overtaking" fixed. It is important to be clear what this means, since it is often expressed very casually and quite inaccurately. In most instances a fixed line is paid for by subscription and is shared by several people, typically a household of several members. Even if not all family members have equal access there should still be a multiplier which can be quite high. By comparison, most customers of mobile operators are pre-paid and the phones are personal. Thereafter, it becomes more complex, since some customers will have more than one SIM card, suggesting that customer numbers should be reduced to avoid double counting.

There are international travellers with SIM cards for many countries, a practice common among those seeking to avoid roaming charges.

Local customers unimpressed with the QoS of any one network will carry a second and even a third SIM cards in order to increase the chances of finding one network that works. Sometimes a second SIM card or even a second handset are used for extra-marital relationships. Business users may have a SIM card for their business phone and another for a personal phone, with a

third SIM card for the data card in their computer. In South Africa SIM cards can be purchased in supermarkets for ZAR 2.00 (US$ 0.35) which suggests that very large numbers may be in circulation, with individuals holding several.

There are also customers in less than entirely legal parts of the economy who may not wish to be too conspicuous. In extreme cases, people are alleged to make are only use of a SIM card and handset, then dispose of it. This is showing up in the loss of customer numbers as countries enforce registration of the individuals (e.g., India, Indonesia and South Africa).

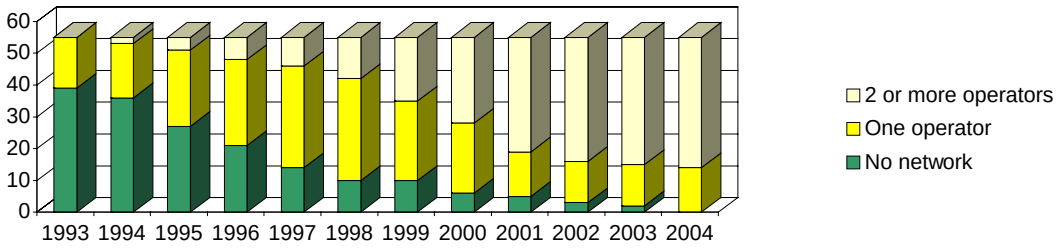
In some instances, commentators add together fixed and mobile "subscribers" often including non-subscribing pre-paid customers. Yet in most developing countries this is compounding the errors, since the few people with fixed lines turn out to be the same people with multiple mobile phones in a family. It is necessary to be very careful with operator supplied data and to match this with survey and census data to arrive at figures for real access to telephony.

The numbers for mobile teledensity tell a positive story, of growing access to telecommunications and of the success of competition in driving that. However, the accuracy of the numbers requires considerable attention before arriving at detailed conclusions. There are risks that numbers are being understated and overstated, so that margins of error must be allowed for.

The low level of competition

The ITU has noted the growth of a second operator in almost all African markets (see figure 9). While a second operator has invariably been shown to drive market growth, it is not sufficient competition to drive down prices and to drive up quality.

Figure 9 *Growth of competition*



More countries are allowing a third and sometimes a fourth operator at which point the effects of competition should become evident. This will be especially important for the development of 3G and 3.5G services where there are no business models and innovation will be essential.

One measure of the concentration in a market is the Herfindahl-Hirschman Index (HHI), the sum of the squares of the market shares (see table 4). The range of values is very wide, but tends

to be highly concentrated. Fiji is an extreme case, where Vodafone remains the monopoly provider, though this will end shortly.

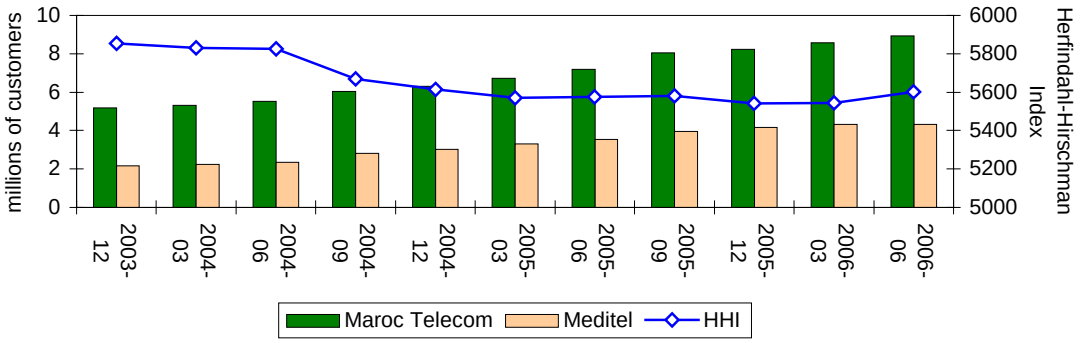
Table 4 *HHIs and mobile teledensities in selected mobile call origination markets*

Country	*HHI*	*teledensity*
Hong Kong SAR	2,200	123
United Kingdom	2,500	102
Germany	3,100	96
France	3,750	79
Japan	4,200	74
South Africa	4,400	65
Ireland	4,900	101
Egypt	5,000	18
Mauritania	5,000	20
New Zealand	5,000	87
Morocco	5,500	39
Fiji	10,000	17

Source: HHIs are calculated from a variety of sources.

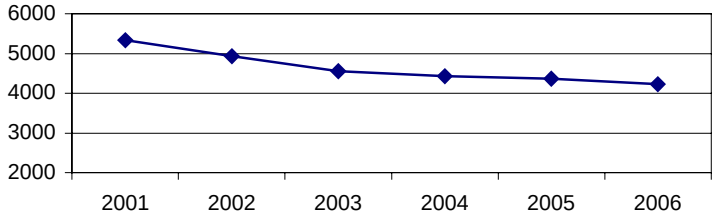
In Morocco the introduction of the second operator led to rapid and continuing market growth of both Maroc Telecom and Meditel (see figure 10). However, it is clear that the market remains highly concentrated and that the HHI will take some years to decline. It suggests that the new third operator entering the market will have a tough fight with two entrenched players, with the risks of price and quality "shadowing".

Figure 10 *Mobile telecommunications in the Kingdom of Morocco* (Source: ANRT)



The South African regulator does not publish market data so that it is necessary to compile data from the various financial reports by the operators: Cell-C, MTN and Vodacom. Figure 11 shows the slow decline of the HHI over recent years. If the markets shares of the three operators were equal, then the HHI would be 3300, which on the present trend will require the passage of many years.

Figure 11 *Market concentration in South Africa*



There has been a considerable measure of consolidation in Africa and the Middle-East. Celtel was acquired by MTC of Kuwait and MTN acquired Investcom, both for very large sums of money. The effect is to allow for the sharing of expertise and experiences between markets and to spread risk. It also allows the possibility of trans-national services (see table 5).

Table 5 *Trans-national footprints of leading operators*

Country	*Celtel*	*Millicom*	*MTN*	*Orascom*	*Vodafone*
Algeria				X	
Botswana			X		
Burkina Faso	X				
Cameroon				X	
Chad	X	X			
Congo (Brazaville)	X		X		
Congo (DRC)	X	X			X
Cote d'Ivoire			X		
Egypt				X	X
Gabon	X				
Ghana		X			
Kenya	X				X
Lesotho					X
Madagascar	X				
Malawi	X				
Mauritius		X			
Niger	X				
Nigeria			X		
Rwanda			X		
Senegal		X			
Sierra Leone	X	X			
South Africa			X		X
Sudan	X				
Swaziland			X		
Tanzania	X	X			X
Tunisia				X	
Uganda	X		X		
Zambia	X		X		

Source: company web sites. Vodafone includes Vodacom. MTN includes Investcom.

There is a need for further research on the levels of competition in African markets and the policy measures that can be used to increase competition and reduce the apparently very high levels of concentration.

Satellite communications

The shortage of infrastructure in most of Africa means that satellite communications play important roles in backhaul, primarily with VSAT, and in direct service provision for telephony, Internet access and for television.

Satellite-based services require that handsets have a clear view of the skies, though LEO services are less sensitive than geo-stationery. They have particular applications in remote areas for the oil, mining and construction industries and for disaster relief and the military. Handsets are expensive, from US$ 750 to 1,500 and given the small size of the market there is limited prospect of those prices falling.

Both Thuraya and Iridium use the ITU "country codes" +8816, +8817 and +88216. The cost of calling these number ranges can be very high, several dollars a minute. Sometimes the number range is not available, requiring two-stage dialling via a number in the USA.

The Iridium project of the late 1990s was undermined by the rapid development of international mobile roaming using GSM which its original backers had failed to anticipate. Instead of offering a service to a mass market, Iridium was left with a niche market. The bulk of business travellers had already discovered the GSM international mobile roaming service using their everyday handset.

Iridium went into bankruptcy in August 1999, being bought out the following year. The new business obtained a large contract from the US Department of Defense, which helped it survive until it acquired commercial customers. By mid-2006, Iridium Satellite LLC, had a subscriber base of 159,000, having grown by one quarter since the previous year. Revenues in the second quarter of 2006 were US$ 53.6 million giving an ARPU of US$ 112 per month. EBITDA in 2006 Q2 was $13.2 million. Commercial services were approximately 70 per cent of its total revenues, the remainder being from the defence and other public sector customers.

The name Iridium came from the atomic number of the element, 77. This was to have been the number of satellites it required, but technological advances reduced that to 66 Low Earth Orbiting (LEOs) satellites. So that it should now be called Dysprosium (Dy). The use of the lower orbits greatly reduces the delay with geosynchronous satellites in much higher orbits.

Thuraya, based in the UAE, offers a hybrid service combining satellite telephony, with terrestrial GSM through international mobile roaming agreements and Global Positioning System (GPS) all in one handset. It also offers a satellite DSL service. Given the substantial gaps in GSM coverage in Africa, Thuraya fills in the gaps, alternatively it can be viewed as using GSM where satellite coverage is difficult, for example inside buildings. The service covers Africa north of Zimbabwe, almost all of Europe and a significant part to up to China and Siberia (see figure 11), with GSM roaming in many other areas.

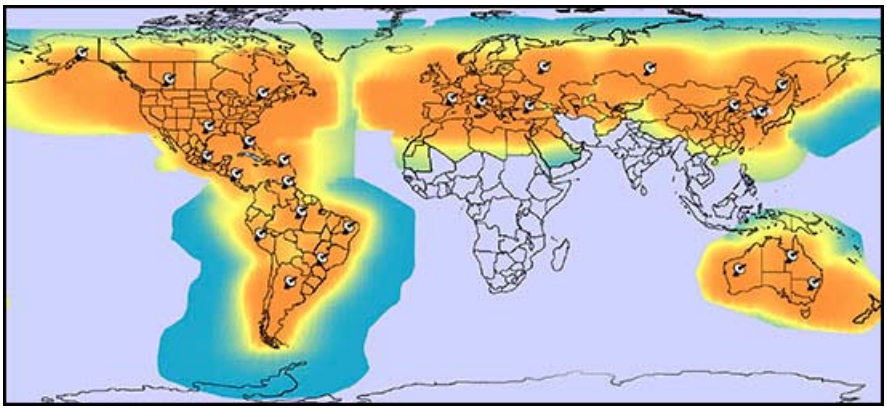
Figure 11 *Thuraya satellite coverage*

Thuraya offers a conventional post-paid subscription service at prices that are affordable only for special applications. It also offers a pre-paid service with an annual renewal fee of US$ 60 which is waived when the usage is more than US$ 2,500, what Thuraya considers a "heavy user".

Both Intelsat and Inmarsat offer a wide range of services from geo-stationary satellites, including VSAT and backhaul, plus services for individuals including voice telephony and broadband Internet access.

Globalstar, like Iridium, is based in the USA and offers a service using LEOs, though only 40 satellites (see figure 12). At March 2006, it had 204,000 subscribers, a 40 per cent increase over the previous year. It estimated that it had 10 per cent share of global subscribers in the mobile satellite services industry in 2005. For 2005 it had revenues of US$ 81.5 millions, equivalent to US$ 33 monthly ARPU. Like Iridium, Globalstar also went into bankruptcy. However, it expects shortly to make an Initial Public Offering (IPO).

Figure 12 *Globalstar coverage*



Satellite services are limited to niche markets, though these are often very important in recovering from disasters and in developing the economy, where they may not be terrestrial networks. The costs are far too high ever to be a mass market, nor is there the capacity. Where there is sufficient demand a terrestrial wireless network makes more sense, though it may connect to the national and international networks using a VSAT link.

The economic benefits of telecommunications

There is a long tradition of research showing that investment in the fixed telecommunications network is positively linked to economic growth.

The Vodafone Group, an exclusively mobile network operator, funded research on the effects of cellular wireless telephony in Africa with a view to showing the economic benefits of the adoption of GSM technologies (Vodafone, 2005). Waverman *et al.* (2005) confirmed that mobile telephony was beneficial for developing economies. However, it was largely as a substitute for fixed telephony and no specific benefits have yet been shown for mobility.

In much of Africa there are no fixed networks or they are on a scale that is so small that it has very modest economic effects. Cellular wireless technologies are therefore a substitute for fixed telephony, with the advantage that the costs are significantly lower than for the construction of traditional fixed networks and are more easily scaleable.

The use of pre-paid cards, much the most common form of access, has made mobile telephony much more accessible than subscription-based fixed telephony. Indeed, the surprise is that fixed operators have not found ways to offer pre-paid services n residential lines.

The business model is very heavily supported by high Mobile Termination Rates (MTRs). The regulation of MTRs has proved to be a considerable and often unequal struggle between

operators and regulators wherever Calling Party Pays (CPP) has been used and the operators have been given a free hand to set prices.

It is unfortunate that there has been no research to separate out the economic value of "mobility" in telecommunications. The issues have become much more complex as the services have expanded from voice and text messaging to Internet access and value-added services. It would be useful to know if there is an economic case for local, national and global mobility. Clearly some of these services sell very well and over long periods of time with pagers, mobile phones, RIM Blackberry devices and the like. Yet, the underlying economics are very poorly understood. Indeed, few businesses can show a cost benefit analysis for such purchases.

In developed countries the incremental effect of mobile phones, on top of widespread access to fixed telephony and now broadband Internet access, would be very difficult to quantify. Much of it will not contribute to economic growth. The epitome or nadir of conspicuous consumption may be teenagers with Dolce & Gabbana Motorola RAZRs calling between SUVs to their friends to discuss the voting for American Idol.

There is also the problem of countries where mobile teledensity has exceeded the population that can use a phone, excluding infants, the very elderly, criminals and the insane. In extreme cases figures can reach 130 per cent. Here there will be individuals with three SIM cards, one for their phone, another for their car and a third for their lap-top computer. Other SIM cards may belong to machines. Clearly large numbers of the "phones" must be considered to play little if any distinct economic role.

For many people in developing countries the capability of GSM networks to allow a call to be handed from cell to cell at 50 mph in a car or 200 mph in a high-speed train is irrelevant. If someone travels by foot, by donkey or by camel, then a hand-over between cells will be rare indeed. The cellular part of the service will be relevant for efficient use of spectrum, but what is being used is effectively the same as a hot spot of a wireless local loop, they are functionally equivalent services. Indeed, in China the use of UTStarcom PAS WLL handset has been very successful, with the possibility of a dual-mode GSM-PAS handset needing to travel further. In the course of a lifetime they may only use a handful of cells.

Research is needed on the relative economic merits of full and partial mobility, especially when compared to nomadic and fixed telecommunications. Much data access appears to be nomadic, even if the technology allows full mobility.

International roaming was created as a means to allow pan-European services. While users have adopted the voice roaming service they complain about the charges. However, the adoption of the roaming data service has been very much slower because there is no business case at the charges shown in Table 2. Nor is there research to suggest there is economic value; no attempt has been made to measure it.

Potential demand

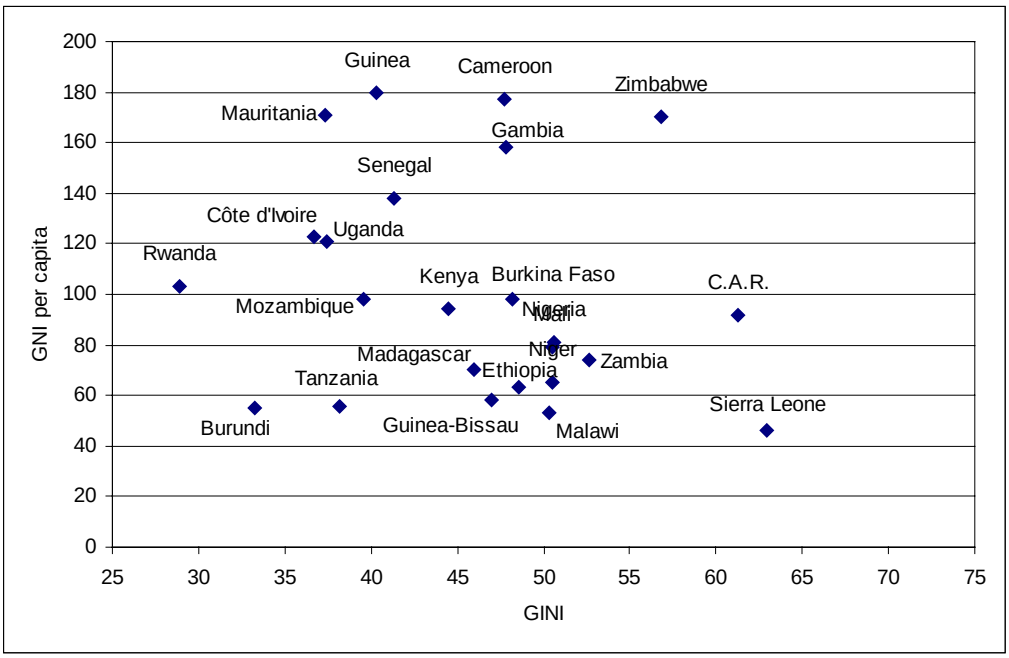
The economics of cellular wireless networks depend on a range of factors, amongst which are the density of the population from which the customers are drawn and the disposable income of the individuals who might become customers, reflecting how much they might spend.

Base stations are built to cover groups of population, requiring a positive cost-benefit analysis, including the cost of backhaul and back-up diesel generators. Recent problems with electricity supplies have required operators to run parts of their networks exclusively or largely with diesel, requiring tankers to circulate replenishing supplies and increased maintenance of the generators. This has greatly increased the costs of operation, requiring retail charges to be increased at least in Uganda.

The income of a country can be measured in many ways. The Gross National Income (GNI) is used the following charts, allowing for Purchasing Power Parity (PPP). It is then divided by the population and then by twelve to give a measure of income of the population. Since income is not evenly spread amongst the population of any country, the Gini index is used as a measure of the inequality of distribution. Measuring the Gini Index requires considerable fieldwork and is not something undertaken regularly in these countries. Nonetheless, it helps to understand how wealth is distributed. European countries have Gini Indices of 25 to 35, while the USA is around 40. Many African countries show much greater inequality than developed economies.

Figure 13 plots the GNI against the Gini Index. The upper left quadrant has higher income and greater equality, while the lower right quadrant has lower income and greater inequality.

Figure 13 *GNI per capita and GINI*



The denser the population the easier it is to serve. As the maps of Egyptian networks above show, the population being concentrated along the Nile valley the extent of the network is much smaller. Despite the large areas of the country with no GSM signal, Vodafone claims to cover 98% of the population.

Figure 14 shows the extent to which populations live in urban areas, plotted against GNI. The countries in the lower left quadrant present greater challenges for operators, since they combine modest to low incomes with largely rural populations. The upper right quadrant is more urbanised and has a higher income.

Figure 14 *Urbanisation*

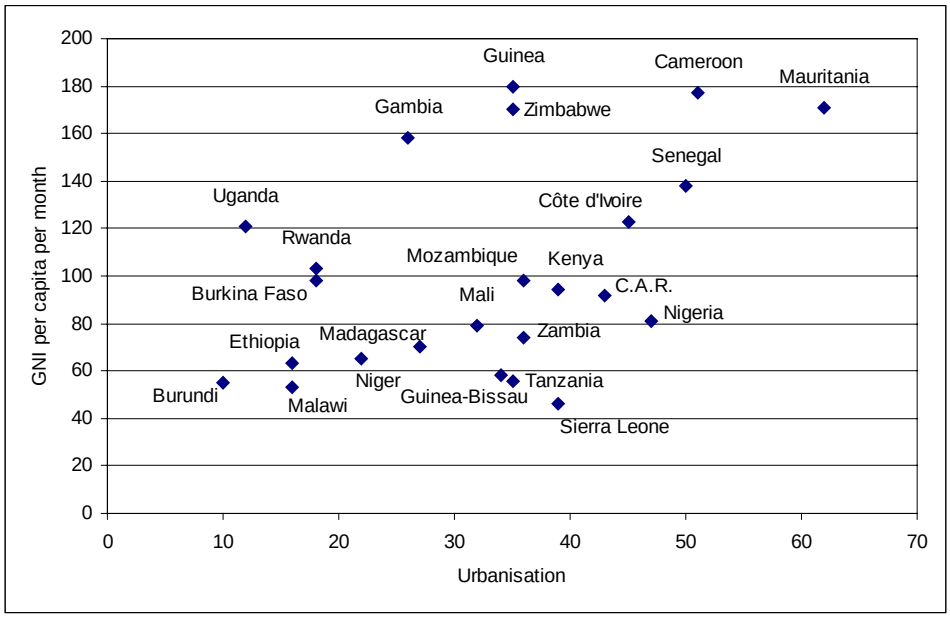


Figure 15 plots the literacy rate against the GNI. This may be less important today, but with the future to be value added services literacy is very important. Indeed, it is important for SMS which can be a significant part of operator revenues. The group in the lower right quadrant have higher levels of literacy, but low incomes which would be a barrier to the adoption of mobile value-added services.

Figure 15 *Literacy*

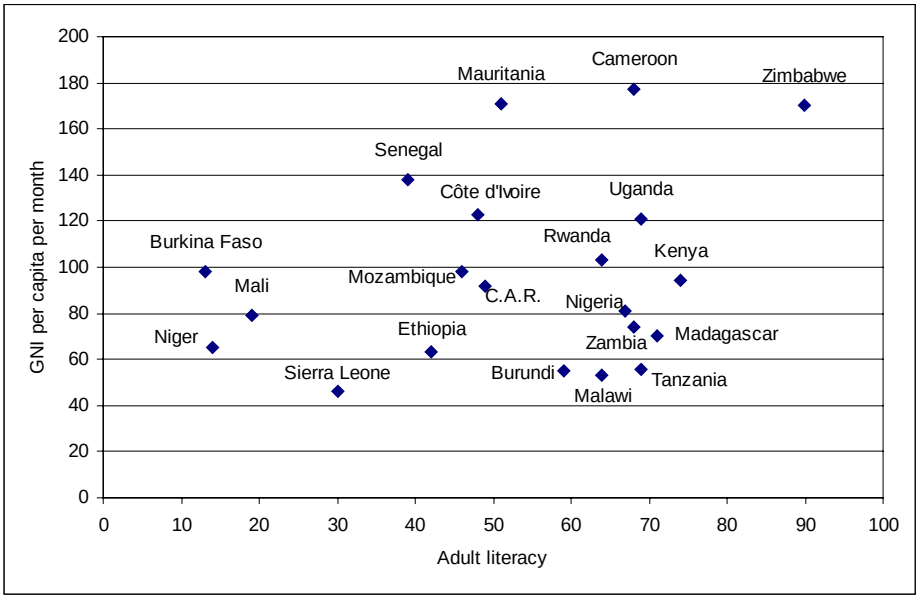
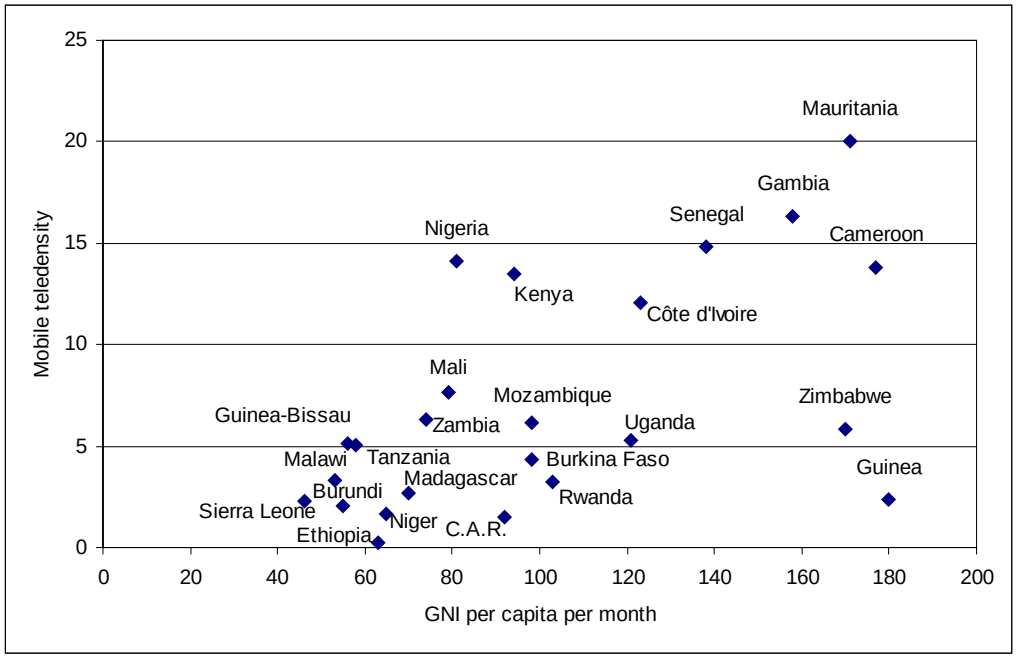


Figure 16 plots the GNI against the mobile teledensity in 2005. It demonstrates a considerable spread in values. Zimbabwe and Guinea stand out as having disproportionately low teledensities.

Figure 16 *Mobile teledensity and Gross National Income*



The concerns about the high cost and unaffordability of roaming are common to many groups of regulators. In addition to the Arab Regulators, the West Africa Telecommunications Regulators Association (WATRA) expressed the need for lower roaming charges and for trans-national services. Similar concerns have been expressed in the Caribbean. ASEAN regulators are currently looking at a similar model to the EU, but lack the legal basis which would require them to act as a sort of regulatory consortium.

If roaming and other services can be made affordable, then the demand is there. The challenges have been to understand the complexity of the issues and to find market structures that will deliver the services.

The solution in Europe

International mobile roaming arose as a regulatory issue in the European Union first as a matter of the operators seeking an exemption from competition law and secondly as a complaint from users about the high level of the charges (Sutherland, 2006).

The creation of a framework for inter-operator agreements by the GSM Association was a violation of Article 81 (1) of the EC Treaty (c.f. Sherman Act §1). The European Commission granted a waiver for this on the basis of Article 81 (3) on the grounds that it was justified by the need to initiate many dozens of roaming agreements in order to make seamless roaming available to customers.

In July 1999, the European Commission launched a sector inquiry to investigate excessive prices for international mobile roaming for possible violation of Article 82 of the EC Treaty. This entailed two sets of questionnaires to be completed by operators and the publication of a working document. There was then a narrowing to cases involving operators in Germany and the United Kingdom that were the subject of "dawn raids" in July 2001. These cases remains open and are apparently at a "critical phase", though any penalties will certainly be appealed to the EU courts in Luxembourg, taking a further four years.

The EC has approved a considerable number of mergers since the mid-1990s, as operators exploited the high value of their stock to engage in cross-border consolidation. In reviewing these cases the EC opposed the introduction of trans-national services, including the elimination of roaming charges, because it would disadvantage smaller operators and might well have triggered even faster consolidation. In the Vodafone acquisition of Mannesmann, the EC obtained a commitment to allow third party wholesale access to any trans-national services. No such services were ever put on the market while the commitment lasted, probably because of the obligation.

One of the accusations in the sector inquiry was that of the lack of transparency of prices. On the day before a hearing of competition and regulation authorities, the GSM Association responded with a code of conduct on the publication of roaming prices. They later employed consultants to show that the operators had complied their own code. The EC returned to price transparency with a web site in October 2005 which it updated in March 2006.[10] Some national regulators also posted pricing data on their web sites in support of the EC. The GSM Association responded with its own web site offering price data in the second quarter of 2006.[11] However, it seems extremely unlikely that any website would put sufficient pressure on the operators to change their behaviour.

The EU directives of 2002 contained an obligation that national regulatory authorities analyse the wholesale markets for roaming. Of the twenty-five member states only four began the formal process, with France abandoning after the public consultation, and only Finland, Ireland and Italy completing. The approach set out in the directives and the market defined by the EC simply do not work and cannot be used to impose remedies on operators.

In July 2006, the European Commission made a legislative proposal to the Council of Ministers and to the European Parliament for a regulation that would reduce wholesale prices and cap the

[10] http://ec.europa.eu/information_society/activities/roaming/

[11] http://www.roaming.gsmeurope.org/

retail margin added by some operators (EC, 2006). It will take some months for this to become European Union law and the retail cap–the subject of considerable debate–may not survive. The benefit to consumers with the retail cap would be around €5.5 billions per annum, but with only the wholesale price regulation it would be around €2.25 billion.

The proposed prices are relatively simple. The wholesale prices would be twice the Mobile Termination Rate (MTR) for a call within the country and three times for a call to another EU member state, to which could be added a retail margin by the home operator of up to thirty per cent. Calls forwarded from the home country would be up to thirty per cent more than the MTR. Additionally, transparency measures were to be introduced, with post-paid subscribers to receive information about roaming prices at the time of concluding a contract and again when any significant changes were made. All customers, including pre-paid, could obtain roaming prices by SMS or telephone call and without a charge.

Figure 17 *Mobile termination rates in Europe at 1 January 2006*

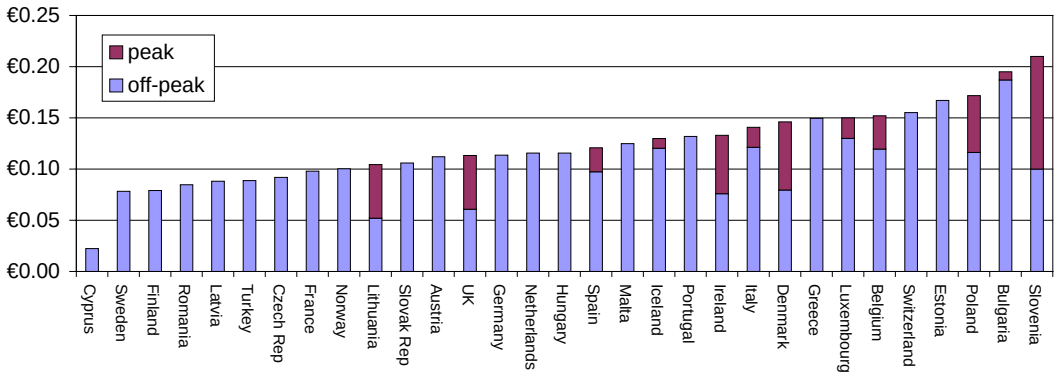


Figure 17 shows the MTRs at the beginning of 2006. These have been the subject of intense debate and effort by EU regulators as they have fought with operators to reduce them to something like cost. Table 6 takes that data as the basis for calculations of the retail roaming prices for a sample of six countries for an inbound call, for a call in the same country and for a call to another EU member state. Calls to other countries are not regulated.

Table 6 *Estimates of regulated prices for roaming calls with regulation (Eurocents)*

	MTR	*inbound*	*national*	*other-EU*
Sweden	7.83	10	20	31
Romania	8.47	11	22	33
France	9.80	13	25	38
Norway	10.03	13	26	39
Greece	14.96	19	39	58
Belgium	13.88	18	36	54

Source: author calculations.

This solution would appear to be confined to the EU as it would be extremely difficult to replicate elsewhere.

Solutions in Hong Kong, SAR

As noted above, Hong Kong SAR has a very competitive market for mobile telecommunications with probably the lowest HHIs. One aspect of the "one country, two systems" is that mobile telecommunications has two systems and that customers must engage in international mobile when going from one to the other. China is now the largest travel destination for Hong Kong and a vitally important economic link.

In such a competitive market it is, perhaps, unsurprising that some alternatives have emerged to conventional international mobile roaming. Many customers who travel regularly to China use international call forwarding which takes the call from the mobile network in Hong Kong, before any air time charges are incurred and forwards it to a mobile number in China.[12] The user must remember to activate call forwarding and to change the SIM card in the handset to that of the Chinese operator and to reverse these settings on their return.

Hutchison Whampoa, as "Three", offers a service with "one SIM card, two numbers", one each in Hong Kong and Macao. [13] This treats the customer as being at home in both, with a combined voice mail and support service. CSL offers a similar service but extends it to cover Hong Kong, Macao and China.[14]

Voice over Internet Protocol

One alternative to GSM roaming is already in use in the form of Voice over Internet Protocol (VoIP) using cheap and usually wireless broadband access at many locations. This tends to be confined to a small numbers of more sophisticated users, especially for inbound calls. It is fairly easy for individuals to use street vendors of GSM calls, telephone shops and Internet cafes for outbound calls at affordable rates.

The OECD (2003) reported steep price reductions among its member states in the cost of international telephony, making it much more accessible and affordable. Competition had encouraged the adoption of newer and cheaper technologies, leading to more diverse offers and much lower prices. The World Bank (2004) addressed the failure of many developing countries to follow the example of high-income countries, despite the evidence of markets with sustainable competition and sharp reductions in prices. The low underlying costs, based on the use of new technologies, were being passed on to customers as a result of the competition.

[12] see, for example, People's service http://www.peoples.com.hk/p_inter_forward_iso.jsp
[13] http://www.three.com.mo/eng/productsnservices/pagebody_1card2number.jsp
[14] http://www.hkcsl.com/inside/promo_onecard/per_whatisnew_justone_card_eng.htm

Cohen and Southwood (2004) argued that the benefits for Africa could be considerable, that VoIP had the potential to transform telephony. Yet often prohibition had been attempted in short-sighted efforts to avoid innovation and competition. Where member states try to ban VoIP they will face growing challenges, as the capability is built into more devices and services, with a growing number of Internet cafés and with more individual users of dial-up and broadband Internet. The latest games consoles are able to act, *inter alia*, as wireless VoIP terminals. VoIP is being added to other devices such as Digital Audio Players (DAPs) and Digital Multimedia Broadcast (DMB) players, which may prove important in the future.

The adoption of Wi-Fi in Africa has been slow for a variety of factors. There is a shortage of cost effective backhaul, in particular of ADSL. There are few lap-top computers and they remain expensive.

In developed countries there are now complex alliances of Wi-Fi providers allowing roaming between suppliers. Often GSM operators offer access to Wi-Fi services using their networks to make and to confirm the payment. Jiwire reports information on hot spots from Boingo, Wayport, Holiday Inn and others. It holds details of 120,106 hot spots worldwide, including over 400 in Africa (see Table 7). Alternative suppliers list fewer than two hundred.

Table 7 *Wi-Fi hot spots in Africa*

country	*Jiwire*	*Wifinder*	*Hotspot Locations*
Algeria	1		
Botswana	1		
Egypt	149	150	148
Gabon	2		
Ghana	7	4	2
Kenya	2		7
Morocco	3	1	6
Niger	1		
Nigeria	29	1	1
Reunion	1		
Somalia	1		
South Africa	234	23	28
Swaziland	1		
Tanzania	2	1	11
Tunisia	1		
Uganda	2		

Source: Jiwire.com, wifinder.com & hotspot-locations.com.[15]

In a small number of countries licences have been issued for WiMAX and services have begun to be rolled out. The possibility of VoIP over WiMAX could offer affordable telephony to large numbers of customers.

[15] Data collected on 19 August 2006.

For many current and potential users of telephony roaming can only be affordable with VoIP at prices of very small numbers of cents per minute or at flat rate prices. That will require considerable structural changes for the industry.

Conclusion

The success of GSM in Africa has been both substantial and unexpected. The scale of global manufacturing for GSM has reduced the costs of handsets and especially network equipment to a level which has allowed the operators to develop the pre-paid business model on an unanticipated scale. There has proved to be very little political risk with mobile telephony. The operators have been able to grow, to enter and to exit markets with surprisingly few problems, a fluidity that has been of considerable benefit to the industry. Moreover, the operators have also proved quite profitable.

The growth of the mobile telephony market will clearly continue in most countries, only South Africa appears close to saturation. However, the operators face significant challenges. They must address populations that are poorer and more widely scattered than in the past. They must also develop business models for 3G and wireless broadband services.

Africa has a GSM monoculture, imported from the former colonial powers. It is characterised by one technology and by one business model. It has comparatively expensive call charges, high mobile termination rates and very expensive international roaming. It is available to many, but for the majority it is and will remain unaffordable.

Wealthy tourists using international roaming make a substantial contribution to the operators, especially in Mauritius, Egypt, Morocco, Seychelles and Tunisia. Business and government travellers to capitals and principal cities also contribute significantly to operator revenues. The first place to build base stations are in the airport and around the best hotels.

For government officials and business travellers from African countries, roaming is a valuable service. It contributes to the operators both in terms of revenues and keeping high-spending customers by offering them a wide range of destinations.

The roaming market structure is unusal, with the retail markets and wholesale markets in different countries. The wholesale operators exchange customers and traffic in complex patterns. With traffic direction the competition, such as it is, is for an operator to be part of a large group that will deliver large volumes of inbound traffic and a wide range of destinations for outbound traffic.

None of the various regulatory solutions for high roaming charges attempted by the European Commission has worked. Even the proposed EU regulation may not succeed. While the EU

created the problem of high roaming charges it can offer little assistance to African countries which lack the sophisticated supra-national legal and regulatory structures of the EC Treaty.

The most recent EC proposal would still result in charges of €0.10 to €0.50 per minute that would be considered unaffordable by many of the 17 per cent of Africans that are already GSM users. For the remaining 83 per cent of the population they are unaffordable.

The commercial models from Hong Kong SAR appear to be applicable in Africa, at least for better-off customers. There are now large operators that could offer a one SIM-card two-numbers solution for South Africa and Tanzania, Kenya and Mozambique, Cameroon and Nigeria. The problem is to find the motivation to drive the operators to provide such services.

With a little effort it is possible to make cheap outbound calls from call centres, Internet cafes and using "plastic" roaming. What is missing are business models to facilitate cheap inbound calls while at remote locations. While service such as Skype are cheap enough for outbound calls, they are not very affordable for inbound calls from the PSTN.

The best hopes for truly affordable roaming lie in VoIP more widely available. However, it will require much cheaper and more widespread access to an affordable IP data service, for example, with ADSL and WiMAX.

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