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Interconnection Challenges in a Converging Environment

Policy Implications for African Telecommunications Regulators

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Introduction

Managing the interconnection interface between the competitive and regulated sectors is crucial for the liberalization of infrastructure services. Interconnection is one of the most important elements of telecommunications policy in a liberalized environment and is needed to achieve equitable and sustainable expansion of infrastructure services in the poorest countries of the world. It also represents a critical challenge for regulators in developing countries needing assistance to introduce the needed changes.

Moreover, during the last decades, radical technological changes have coincided with a first wave of reform making a positive impact in developing countries. This positive impact was partially accidental, and it resulted from a combination of internal and external pressures to open telecom markets and from the transfer of Global System Mobile GSM) technology. Mobile diffusion generated economies of scale from its deployment in mature markets. In Africa, with the change in regulatory framework and the development of plural and competitive networks, fixed-to-mobile (FTM) and mobile-to-fixed (MTF) interconnection has become one domain requiring huge technical, financial, and economic expertise.

For policy makers, regulators and development agencies in the developing world—particularly in Africa—this situation presents a difficult challenge. In order to address the challenges and opportunities that are likely to emerge with the adop-

tion of new technologies (in particular with the migration to packet switched networks), there is a need to anticipate regulatory and policy models. As traditional approaches to regulatory and policy may hamper market functioning, it is critical that new analytical tools and methods be developed to address the major paradigm shift.

Meanwhile, there is no comprehensive theoretical framework to rely on and efforts to build a theory of regulation for less developed countries are still in their infancy (see Laffont [2005]). The lack of a theoretical framework is put to the test when considering interconnection issues, while the specificities of African network operators and usage guide the review of the current paradigms of access pricing.

The purpose of this paper is to show how interconnection regimes can be adapted to the African specificities in a context of convergence and increased competition. It analyzes how interconnection regulation in Africa has been defined at the onset of the convergence phenomenon (i.e., FTM substitution), and explores the issues related to new technologies (for example Internet protocol [IP] telephony) and interconnection regulation policies.

Considering African regulators have not yet been able to effectively and efficiently implement the traditional interconnection regime, it may appear quite challenging, if not provocative, why should one worries about the potential or possible challenges stemming from a probable environment? The very issues raised by the migration of traditional circuit switched networks to IP networks have yet to be well understood in developed countries, why converging environment is already a challenge for interconnection in Africa? The paper relies on the belief that Africa may be affected because of the technology leapfrog and the growing availability of a number of "disruptive technologies" that are offering the possibility of cheaper access to voice and data (VoIP, Wi-Fi, Wi-MAX, CDMA, EDGE, VSAT) than traditional wireline. They are more and more African countries which are moving from a technology licensing regime to a technology licensing regime in order to adapt to a converging environment. The regulator in Tanzania (TCRA) has migrated to a converged regulatory framework, and they are probably many others implementing such transitions to date.

This paper is organized into two parts; the first describes how interconnection issues remain at the core of the African regulatory context, and unveiling African market configurations and specificities in the domains of interconnection between fixed and mobile markets, regional interconnectivity, and the Internet. The second part considers two converging areas (FTM and voice over Internet protocol [VoIP]), and describes the response of international regulators to adjust regulatory practices

to innovations. These indications document the consequences and repercussions on the future interconnection debate. This part will provide a two-fold analysis: an *ex-post* assessment of regulatory regimes in FTM interconnection, and an ex-ante set of interconnection-related issues likely to emerge in the context of the development of VoIP markets.

PART I. Pending Interconnection Issues for Regulators and Industry in Africa

1.1 Operators' Strategy and Regulation

Interconnection issues have been a major challenge throughout the Africa. The incumbents' reluctance to sign agreements has had a stifling effect on competition. These difficulties pose a significant barrier to investor confidence and need to be removed to ensure sustained development. Another factor which has been deterrent to competition in Africa is also the inability of newly established regulators to clear or settle disputes.

Defining Interconnection Regimes

In this paper the term "interconnection," refers to the physical and logical linking of public electronic communications networks used by the same or a different undertaking in order to allow users of one undertaking to communicate with the users of the same (or another) undertaking, or to access services provided by another undertaking. Interconnection has the purpose of allowing, in a context of plurality of operators, any communication between two unspecified users.

Interconnection terms and rates strongly influence new entrants' investment decisions. They create great operator anxiety over operational and cost implications of different interconnection carrier compensation models. Unfair terms and high rates will discourage entry or expansion. High rates can also lead to inefficient investments aimed at bypassing interconnection, as well as high consumer tariffs. It is well known that unbalance interconnect practices and weak regulation have plagued and hindered the emergence of true multioperators and competitive markets.

Access is an essential element for competitors. The economic and technical conditions for competitors to access the regulated sector determines profitability at entry, as well as the level of competition in the sectors opened to competition. This also

indirectly dictates the level of efficiency in the use of the elements of natural monopoly (see Laffont, 2005, p.118).

The contribution of termination revenues to overall revenues is considerably higher for mobile than for fixed operators. Typically, as Table 1 shows, this contribution is around 25 percent, though this figure varies from operator to operator.[1]

Table 1. Contribution of Mobile Termination Revenues to Overall Revenues

Country	Operator	Percentage of overall revenues
Democratic Republic of Congo	Celtel	27
Greece	Telestet	29
Netherlands	Vodafone Libertel	25
Portugal	Optimus	25
South Korea	SKT	25
South Korea	KTF	25
UK	O2	24
UK	Orange	26
UK	T-Mobile	29
UK	Vodafone	20

Source: Ovum, CSFB, Morgan Stanley, Merrill Lynch, Celtel

Interconnection terms and rates also deter incumbents' ability to invest. Clearly, the pricing of interconnection services induces disincentives for investment in general. As an example, in the United States, broadband has not taken off because incumbents have been reluctant to invest (traditional hold up problem). In developing countries, the pricing methodology advocated during the past years has also deterred some investments from incumbents.

Interconnection and Access in Remote Areas

The rural network in low income countries and remote areas presents significant potential to increase revenues and to generate traffic. This is mainly due to the fact that, independent of the willingness of the rural community to pay, urban users enjoy more affordability and are more willing to pay for calls. It is largely accepted that,

[1] Currently interconnection revenues represent more than 30 percent of China Unicom EBITDA and interconnection costs count for more than 20 percent of the OPEX of TIM Brasil.

for rural communications, probably more than 50 percent of the operator's potential revenues could come from incoming (i.e., urban to rural calls) traffic. This large imbalance between incoming and outgoing calls from/to areas with different levels of affordability and willingness to pay, is also true for international traffic flow. For example, in the Democratic Republic of Congo (DRC), during the first half of 2004, the international incoming traffic volume was three times larger than that of outgoing international traffic. As the Table 2 shows this unbalance between Incoming and Outgoing traffic can be observed in many African countries.

Table 2. National Traffic Balance in African Countries FY 2003/04

Country	Incoming	Outgoing	Surplus
Burkina Faso	39.1	30.5	8.6
Côte Ivoire	138.1	64.9	73.2
Gabon	36.5	32.9	3.6
South Africa	920.6	570.5	350.1

In millions of minutes of public switched telecommunications traffic
Fiscal year ends 31 March
Source: Telegeography

In South Africa, studies related to the awarding process of under-serviced areas licenses (USALs) as a means to stimulate the activity and provide services to areas with a teledensity below 5 percent, have shown that without an asymmetrical termination interconnection regime, grants and favorable funding arrangements offered by the universal service agency were not a good incentive to make USAL licenses viable and attract investments. At public hearings on the terms of the licenses, aspirants to USALs argued that a favorable interconnection term was a critical component of most of their business plans, and that without a termination rate increase as high as 50 to70 percent, a rural licensee would not be viable.

For mobile operators a natural consequence of the high percentage of total revenues resulting from mobile termination is that this issue has become a strategic and management issue. As in Europe, the African mobile operators' primary concern is to protect their mobile termination rates and to mitigate the natural decline in the termination revenues' business.

Regulatory Arbitrage and Regulatory Dispute at a National Level

Regulatory arbitrage results when stakeholders (such as telecommunications services), exploit differences in legislative and regulatory classifications to accrue financial and competitive advantages achieved by avoiding regulatory burdens, or by foisting payment obligations onto other carriers.

Interconnection mandates and price setting are key regulatory issues (see Bezzina 2004). Enforcement of operators' obligations and dispute resolutions are also a core strategic issue in telecommunication sector regulation. African regulators usually suffer from discrepancies between *de jure* and real capacity and enforcement powers; and in many countries regulators' powers (on paper) largely exceed their actual ability to enforce regulations. This situation has many causes, for example, the existence of multiple actors with overlapping responsibilities. Prolonged unresolved disputes may seriously hamper investment and competition by making interconnection, *de facto*, unavailable.[2] In Ghana, historic interconnection difficulties are so severe as to cause lengthy delays in the launch of services by new entrants.

As market liberalization advances, African regulators are increasingly facing up to the challenge of providing effective resolution efficiency. Progressively, implementation and enforcement of efficient and effective interconnection dispute resolution processes become a necessary hallmark of a mature telecommunications market.[3] Almost every African country has had a mobile interconnection dispute. Table 3 summarizes a partial selection of interconnection disputes.

A question remains particularly relevant in Africa, whether interconnection disputes arise because of the underlying market structure or due to the regulators' profile? The extraordinary growth of mobile services and resulting transformation of the telecommunications sector has created competitive challenges both to fixed-line operators and interconnection regimes. In most Sub-Saharan African (SSA) countries, mobile penetration has overtaken fixed-line services, and the ratio of mobile to fixed penetration rates is remarkable (Table 4 on page 8). Other issues specific to SSA are the lack of a cost-based tariff system, along with discrepancies between the traffic measurements of different operators.

[2] It is also the case that lack of interconnect capacity has inhibited network growth as severe congestion leads to reduced quality of service (QoS), which leads to reputation damage and slower take-up of subscriptions.
[3] See Key Finding from ITU Interconnection Dispute Settlement Mini Case Studies (www.itu.int)

Table 3. Interconnection Disputes in Sub-Saharan African Countries

Country	Issues	Resolution
Botswana BTC (Botswana Telecommunications Corporation) vs. Mascom Wireless	MTF and FTM Termination Cost	On February 2003 BTA issues its Ruling No.1 of 2003 in the dispute by setting new interconnection charges through reliance on international benchmarks
Guinea Bissau	MTF and FTM Termination Cost	The regulator put in place an interim interconnection rate that will be in place till March 2005. Still Ongoing.
Kenya Kencell Communications Ltd (Mobile operator) *vs.* TKL (Fixed line operators)	MTF Termination Cost	Decision by CCK was appealed in the Appeals Tribunal. By 2003, Tribunal delivered a judgment on interconnection rates dispute which decided in favor of the CCK Decision.
Lesotho	MTF and FTM Termination Cost	Operators entered into commercial negotiations and agreed to the terms of interconnection including pricing. Regulator has not approved the negotiated rates because they would amount to an increase in end-user rates. The tension is now at its peak and operators expressed strong doubts whether the regulator has the requisite capacity to regulate interconnection pricing. Ongoing.
Malawi	MTF and FTM Termination Cost	After failed attempts to reach interconnection agreement using commercial negotiation, the regulator stepped in and mandated a new rate (flat rate for FTM and MTF. The rate constitutes 50 percent decrease of the proposed rate by the incumbent. Yet, mobile operators are complaining that the new rates are still very high and constitute a major impediment to the development of the sector.
Mozambique TDM (Telecomunicações de Moçambique E.P.) *vs.* Vodacom	MTF and FTM Termination Cost	INCM, at the request of Vodacom issued in December 2002, a Decision mandating Vodacom and TDM to establish an interim interconnection agreement.
Tanzania Cellnet Tanzania (Mobile subssidiary of TTCL) *vs.* Mobitel, Vodacom and Tritel	MTF and FTM Termination Cost	In July 2004, TCRA announced a decrease in interconnection charges between the different operators.
Uganda UTL (Uganda Telecom Limited) vs. Celtel	FTM Termination Cost	In 2003, after years, UCC implemented a default interconnection agreement

Source: Author Compilation

Table 4. Top 10 Mobile/Fixed Subscriber Ratio in 2003 and 2004 (estimated)

2003		2004	
Cameroon	9.4	Mozambique	11.9
Congo	43.6	DRC	155.9
DRC	123.7	Congo	197.9
Gabon	10.2	Cote d'Ivoire	11.9
Guinea-Bissau	11.9	Gabon	12.4
Kenya	7.2	Guinea-Bissau	11.7
Liberia	6.9	Liberia	10.9
Mauritania	9.2	Tanzania	11.9
Tanzania	7.6	Cameroon	11.8
Uganda	12.7	Uganda	15.6

Source: EMC and ITU

The dramatic increase in the number of mobile subscribers in SSA has resulted in a power shift in the sector: mobile operators now generate most of the traffic, both domestic and international. This market dynamic has put pressure on interconnection agreements between operators with the following three consequences:

(a) Greater pressure for mobile operators to be licensed to operate their own international gateway.

(b) Revenue sharing and competitive positions favorable to mobile operators as fixed incumbent operators retain no significant market power in many countries. This situation may be revealing some inadequacies in the asymmetric regulatory framework originally adopted. This framework was often based on European models aimed at mitigating the incumbent fixed operators' dominance rather than to develop network and access infrastructures.

(c) In some SA countries, the regulatory process cycle lags compared to market developments. In the early stages of competition, market vitality needs flexible dispute resolution systems to ensure that the market can accommodate underlying sector changes, however, this is not the case in SSA. Rwandatel (fixed) and MTN-Rwandacell (mobile) negotiated an interconnection regime and termination charges, in 1998 when there was no regulatory body. These agreements have not been revisited since then, though the market's development has completely reversed the situation between operators.

2.2 African National Market Configurations

Mobile operators' growth in SSA calls for crucial interconnection issues to be addressed rapidly. In this region, more than anywhere else, mobile operators have rolled out their base station infrastructure faster than the plain old fixed telephone incumbent. They have covered the majority of the population by meeting strong pent-up demand and rapidly and have achieved financial success, with a positive impact on the overall development of the continent. However Interconnection (with the incumbent's) to trunk mobile calls over long-distance and access termination to the last mile remain crucial to ensuring end-to-end services within an (apparently) seamless communications network.

Regional Issues: Cross-border Interconnection, Poor Regional Interconnectivity

At a regional level, Africa is characterized by a lack of functional terrestrial international links between countries, scarce interconnection between national terrestrial microwave and fiber circuits, and poor quality and insufficient capacity of existing international links.[4] Due to the lack of significant international communications infrastructure, much of the international voice and data traffic (both within and between countries) is routed either directly by satellite or transited via Europe or North America.

The lack of regional backbone infrastructure generates a scarcity of cheap international bandwidth discourages interregional trade and impedes Africa's participation in the international economy at more global level. During recent years Africa's experienced impressive growth of outgoing international traffic originating in Africa (Table 5). In the Economic Community Of West African States (ECOWAS) countries, traffic growth between 2002 and 2004 has been above 105 percent.[5]

Table 5. ECOWAS Region: International Outgoing Traffic Growth (2002 to 2004)

Country	Growth Rate (%)
Burkina Faso	101
Cote d'Ivoire	97
Ghana	73
Guinea	56
Guinea Bissau	500
Niger	205
Nigeria	166
Senegal	159
Togo	73
Total ECOWAS	106

Source: Author calculations

[4] In West Africa, several operators do not have direct terrestrial links with one another.
[5] The 15 states that constitute ECOWAS are: Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, andTogo.

In 2002, 79.4 million minutes originated in Africa and were transited through the United States (US). The level of transit charges paid to US carriers was $20.4 million, of which $5.5 million covered the ECOWAS region, $3.1 million covered the seven East Africa Submarine Cable System (EASSy) anchor countries,[6] and $3.9 million covered other Eastern countries that are interested in connecting to EASSy through terrestrial means.[7] Also, recently it was estimated that the use of international bandwidth for national or regional data costs Africa around $400 million a year (Via Africa, 2004).

In the late 1990s, as regards bilateral links between Intra-African countries, bill and keep (B&K) regimes[8] have been progressively replaced by bilateral negotiated interconnection agreements in Southern and Eastern Africa countries. With the entry into service of submarine cable systems, landlocked operators and gatekeeper carriers are inherently unequal partners in bilateral interconnection negotiations. This is the reason that, since June 2003, the EASS interconnection agreements have abolished the B&K regime between operators.

Together with cross border interconnection, the backhaul charges for carriage through an intermediary country are another interconnection-related issue that hinders market development in Africa. Landlocked operators need to interconnect with the carrier in the intermediary country, and to pay that operator to backhaul traffic to the landing point. This creates potential bottlenecks if, for example, the landlocked operator is forced to interconnect with the incumbent in a monopoly environment. That some countries are landlocked and others are not is an accident of geography. However, bottlenecks exist when licensed operators and landlocked carrier are unable or unwilling to access alternative upstream fiber infrastructure through gatekeeper carriers, and therefore cannot switch to another supplier.

One-way to Two-way Access Background: Dominance, Fixed-mobile Competition and Booming Mobile Markets

One-way access regimes imply that one company needs access to the other (but the reverse does not hold). This is the case, for example, when a long distance entrant needs access to the incumbent local network. The entrant carrier therefore

[6] EASSy is a fiber optic cable project proposed to connect seven coastal countries in East Africa, including: Djibouti, Kenya, Madagascar, Mozambique, Somalia, South Africa and Tanzania. The estimated cost of EASSy is US$300 million.

[7] The 15 interested EASSy countries are: Botswana, Burundi, Comoros, DRC, Eritrea, Ethiopia, Lesotho, Malawi, Rwanda, Seychelles, Sudan, Swaziland, Uganda, Zambia, and Zimbabwe.

[8] B&K, sometimes referred to as Sender Keep All refers to an interconnection arrangement where a carrier agrees to accept traffic from another carrier in exchange for a reciprocal agreement. The carriers make no financial payments to each other.

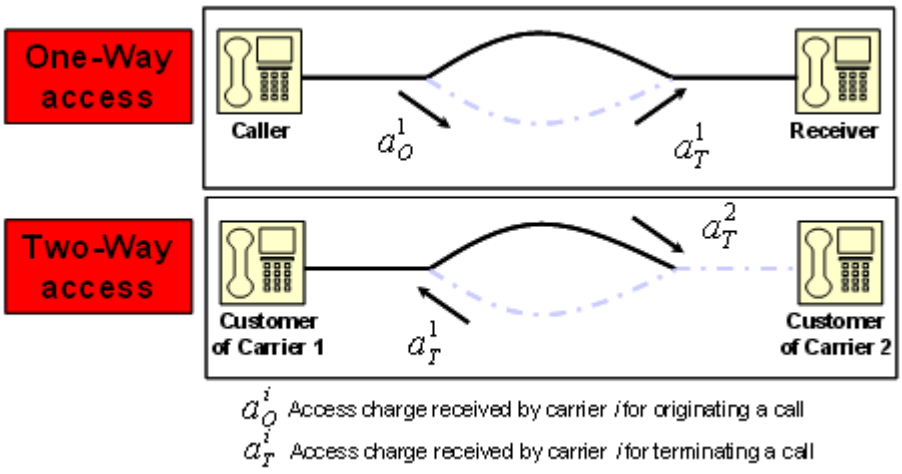
Table 6. Africa - Main Impediments to An Open, Fair, and Pro-competitive Access to Backbone Infrastructure

Main Restrictions/ Bottleneck	Issues at stake
Cross-Border Licensing	- No regime in place to facilitate the building of Cross Border links - Major obstacle to the realization of integrated telecom market
Access control in gatekeeper operators	- 'Gatekeeper operator (for instance in the case of access to international submarine cable) can successfully use its monopoly on international traffic or exclusivity to satellite to maintain high charges
Cross-border interconnection and settlements for international traffic	- Landlocked operators need to interconnect with the carrier in the intermediary country and pay that operator to backhaul traffic to the landing point (this creates potential bottlenecks) - Lack of cost-based wholesale services for landlocked operators

buys both origination and termination access from the incumbent carrier to be able to offer a long distance service. In Figure 1, for example, Carrier 2 buys both origination and termination from incumbent carrier.

Besides issues relevant to pricing one-way-access, a new set issues has developed in parallel to the implementation of local competition on two-way interconnection (Laffont and Tirole, 2000). In this situation, each carrier must then buy termination access from the other network.

Figure 1. One-way -vs- Two-way Network Access



Although one-way access remains a central issue in the opening of a number of segments to competition, it is important to consider that—in SSA more than anywhere else—the success in the development of mobile operators has given rise to a set of issues on two-way termination access charges. In Africa the demand for

mobile services has caused some mobile operators to build their own national backbone infrastructure (which is contrary to fixed-line services that have failed to meet demand and have not seen the necessity to build out backbone infrastructure).

In a world of one-way access, Company A needs access to Company B, but this arrangement is not reciprocal. By contrast, in a world of two-way access, customers calling each other belong to two different local networks, implying that each carrier must buy termination access to the other network.

The regulatory experience at the end of the 1990s, both in the developed and developing worlds (see ART 1999, ANRT 2000) shows the extent that charges for termination on the mobile network are often considered to be excessively high, becoming major sources of regulatory disputes (Table 3). This is due to the fact that in a calling-party-pays (CPP) interconnect regime,[9] terminating mobile operators have simply no incentives to lower their termination prices. Mobile users are indifferent to the price for the call delivered on their network, since they do not pay for incoming calls. Fixed operators have no alternative for delivering a call to mobile subscribers than using a mobile operator's terminating access service: thus, call termination on the mobile network may be considered a bottleneck.

In Africa, the situation of mobile operators enjoying a terminating monopoly on termination networks is aggravated by the lack of equilibrium in market power between fixed and mobile operators.

Table 7. Top Five Gaps between Annual Growth Rate in Fixed and Mobile Subscribers between 2002 and 2003

SSA	Mobile (%)	Fixed (%)		Europe	Mobile (%)	Fixed (%)
Algeria	1030.65	15.28		Norway	0.84	-3.26
Ethiopia	2740.00	22.95		France	-0.16	-0.64
Guinea Republic	850.26	0.68		Iceland	19.05	1.45
Madagascar	104.77	0.18		Spain	5.60	0.67
Tunisia	279.53	1.33		Germany	7.19	1.08

Source: EMC and ITU

[9] CPP is the arrangement wherein the mobile subscriber does not pay for incoming calls. Instead, the calling party pays for those calls (see below Part2, § 2.1, Fig.2).

By contrast with the Organisation of Economic Cooperation and Development (OECD) countries (which are reaching saturation in terms of mobile penetration), SSA countries have a booming mobile market in its early stage or an advanced market with few years before reaching saturation. This may have important consequences on the anticipated balance of traffic flows between interconnected networks, on the termination volumes and on their impacts on revenues. The combination of slowing traffic growth and dropping mobile termination rates over time will inevitably lead to falling termination revenues for mobile operators in OECD countries. On the contrary, mobile operators in SSA countries may enjoy a combination of traffic growth and steady rates likely to positively impact termination revenues in the coming years.

Interconnection and the Internet in Africa

A precondition for regional B&K regimes between Internet service providers (ISPs) within a given region is the presence of regional transmission infrastructure in order to carry that traffic. Thus, for Internet traffic, the main purpose of cross-border infrastructure is to facilitate access to long-haul submarine fiber links.[10] The lack of significant international infrastructure is likely to impede Africa's ability to exchange traffic at a national level and regionally within the continent. This situation brings serious disadvantages in terms of cost savings, access speed, and latency.

Table 8 illustrates the huge difference in prices between international and domestic leased lines in Egypt, Kenya, Morocco, and South Africa. Depending on countries and bandwidth, international connectivity charges can be from 15 to 26 times their equivalent local costs.

Table 8. International and Domestic Leased Lines in Egypt, Kenya, Morocco, and South Africa (Ratio between USA international leased line price and local domestic leased line)

	256 k	512 k
Egypt	15	13
Kenya	18	15
Morocco	20	17
South Africa	26	24

Source: Author calculations

The lack of infrastructure implies that a considerable amount of voice and data traffic (both within and between African countries) goes via Europe or North America. This raises additional issues in terms of quality of service. Using interna-

[10] As an example, such is the requirement for this upstream connectivity, that, by March 2005 Onatel (Burkina Faso) had increased its international Internet bandwidth to 34 Mbps from 4 Mbps in 2003, and until it access Sat-3/WASC via Benin all of this bandwidth is provided by satellite.

tional bandwidth for exchanging local traffic seriously slows down traffic exchange and makes the use of bandwidth unaffordable.

ECOWAS' lack of physical infrastructure between countries reinforces the dependency of ISPs' on external carriers to route traffic. Where incumbent fixed-line operators have established direct point-to-point satellite routes, the cost of the satellite transmission is as expensive as long-haul routes to Europe or the US. An ISP would therefore either be forced to use the link to Europe or to the US as this is the only option that exists, or has commercial reasons to use it. This situation is reinforced by the scarce competition on bilateral routes between ECOWAS countries operated by national carriers, in comparison with those operated by rival wholesale carriers to US or Europe.

Internet traffic flows imply that African ISPs must achieve connectivity through Tier 1 Internet backbone providers.[11] It is also noteworthy that, at the end of December 2004, they were only ten national Internet exchange points (IXPs) in Africa.[12.] Table 9 gives the characteristics and traffic flow through African IXPs.

Table 9. Traffic Flow Through African IXPs

Country	IXP	Established	No. of ISPs	Traffic Vvolume
Egypt	Cairo CR-IX	December 2002	9	
Tanzania	Dar es Salam TIX	January 2004	10	1 mbps
Nigeria	Ibadan IBIX	March 2003	2	200 kbps
South Africa	Johannesburg JINX	December 1996	15	45 mbps
Uganda	Kampala UIXP	July 2003	5	
Rwanda	Kigali RINEX	July 2004	6	400 kbps
DRC	Kinshasa KINIX	November 2002	4	1 mbps
Mozambique	Maputo MOZ-IX	July 2002	7	4 mbps
Swaziland	Mbabane SZIXP	June 2004	3	128 kbps
Kenya	Nairobi KIXP	February 2002	11	3 mbps

Source: PCH – Packet Clearing House

[11] The original definition of Tier-1 was a network that is fully-peered, hence that it has every route on the internet without having to transit routes.
[12] DRC, Egypt, Kenya, Mozambique, Nigeria, Rwanda, South Africa, Tanzania, Uganda, and Zimbabwe.

Within ECOWAS only a small portion of the IP traffic is destined from one ECOWAS country to another. By March 2005, the only[13] IXP in the region was Ibadan (Nigeria) and there werecurrently no IXPs in francophone West Africa.

It is largely accepted that the high price of bandwidth is a key-inhibitor of Internet development in Africa. This situation, as emphasized by the African Internet Service Providers Association in its 2002 influential policy paper (AfrISPA 2002), can be partly explained through the actual unfair distribution of bandwidth cost-sharing, which is currently driving traffic out of African Internet backbones and into international backbone providers. Typically, as most of the international backbone providers operate within G8 countries, the major part of the cost for African Internet backbones to obtain upstream connectivity is the physical link from them to the international backbone providers country, and a tiny part is the cost of purchasing IP bandwidth once they get there. In other words, on the Internet, the net cash flow flows from the developing South to the developed North.

In Africa absent the International Telecommunications Union's conventions governing interconnection principles for voice traffic and sharing the costs between each side involved in the transaction (each is paying for a half circuit), Internet transactions are based on a full circuit cost. This unfair situation makes African Internet backbones subsidize the connectivity costs for International backbone providers, to the extent that the current burden of paying international bandwidth costs by African operators are estimated to cost the whole continent between $250 million and $500 million a year (AFRISPA, 2004).

Part II. New Issues in Interconnection Regulation in Sub-Saharan Africa

1.1 Regulation and Interconnection's Impact on Operations

Adopting and enforcing interconnection regimes in the SSA context is likely to challenge costing practices, estimaties, and burdens. For example, due largely to the monopoly provisions and the one-way access background (sender and receiver being on the same network), traditional access pricing in SSA has failed to recognize both origination and termination costs.[14]

[13] The forthcoming Ghana Internet exchange will link ISPs and NSPs in the Greater Accra area to an IXP housed at the Kofi Annan Centre for Excellence in ICT. The exchange is currently being built.
[14] The fundamental concerns about how costs are actually worked out is discussed in Bezzina (2004).

Regulatory Implementation Options and Regimes for Interconnection

Adoption of a price interconnection regime that meets European and US regulatory standards depends on the type of market considered. Figure 2 shows some of the most current regulatory implementations options available for telecommunications networks interconnection.

Figure 2. Options for Pricing Interconnection Telecommunications Networks

Option 1 Bill and Keep	**Option 2** Free negotiation	**Option 3** Price regulation of the dominant operator	**Option 4** Symmetry in price Regulation
Examples			
France: mobile to mobile calls (until 2003)	US: competitive local exchange carriers, UK: mobile to mobile (Until 2002);	EU: "New" European Regulatory framework (2003);	UK: traffic between incumbent and new entrants (2002).

In the rest of the paper, implementations options are differentiated to regulatory regimes. Regulatory implementation options are on a different level of abstraction from regulatory regimes. A policy option, refers to the practical implementation of a policy, while a regulatory regime is more generic and tries to offer a framework by which policy makers can subsequently implement the variety of regulatory regimes, the changing patterns of national regulation and the evolving structure of telecommunications markets.

Three regulatory regimes are described below: Calling-Party's-Network-Pays (CPNP), Bill and Keep (B&K) or sender-keeps-all and Revenue Sharing Arrangements.

Under the *Calling-Party's-Network-Pays (CPNP)* arrangement, the calling party's network pays to terminate a call on another network. This system requires the calling party's carrier (whether fixed or mobile) to compensate the called party's carrier for terminating the call. This interconnection regime is dominant in Europe.

The traditional rationale for CPNP regimes is based on the following theoretical economic background: access charges (i.e., interconnection rates) are designed in the context of increasing return-to-scale to recover the full costs of a local network while at the same time ensuring efficient use of the network. The application of such a Ramsey-type analysis (to determine the optimal increase of price above marginal

cost) is based on a simple assumption that the parties involved in the phone call can "internalize" any externality caused by charging only the calling party by simply trading phone calls.[15]

However, some pressing issues arise from such an interconnect regime (see FCC 2001). First, this system creates strong incentives for regulatory arbitrage;[16] if they are inefficiently structured or set, interconnection rates may generate undue profit for each terminated minute, creating a potential windfall for networks that primarily (or exclusively) receive traffic. Second, implementing such a regime involves terminating access monopolies: originating operators have no choice but to purchase terminating access from the carrier of the called party.

Bill & Keep (B&K) or sender-keeps-all is a model of bilateral interconnection agreements in which the originating operator keeps the revenue billed. This model works well as long as traffic flows are balanced, and avoids the need for the terminating operator to have accounting and billing systems to monitor the flow of traffic. B&K was designed for three situations: nearly balanced traffic flows, information issues (i.e., VoIP), and settlement problems. Because no termination charges are required, each carrier recovers the costs of termination (and origination) directly from its own end-customers.

In France, with a relatively balanced traffic between the interconnecting carriers, the B&K interconnection regime was adopted for mobile-to-mobile (MTM) communications until 2004. The strong price differential introduced by this regime on the termination charges on fixed and mobile networks has sometimes been considered as a clear incentive for the development of GSM gateway, and dedicated to substitute MTM to FTM termination (Conseil de la Concurrence 2004). In the US, the B&K approach has inspired the Federal Communication Commission's economists to build the models: Central Office Bill and Keep (COBAK) and the Bill Access to Subscribers, Incremental Interconnection Costs Split (BASICS) to allow efficient and competitively neutral approach to network interconnection (DeGraba, 2000), (Atkinson & Barnekov, 2000). Southern Africa has moved away from the B&K regime in the late 1990s. Kenya, Tanzania, and Uganda, with four fixed-line operators and nine cellular operators, set August 2003 as the original deadline to abolish the B&K regime between operators in the region.

[15] In other words, CPNP regimes are based on the premise that the originating caller receives all the benefits of a call and should, therefore, bear the costs of both origination and termination.
[16] This term refers to profit-seeking behavior that can arise when a regulated firm is required to set different prices for products or services with a similar cost structure (see DeGraba, 2000).

B&K arrangements would progressively be replaced by commercial interconnection arrangements with termination charges negotiated bilaterally between operators. Usually, in a B&K system, the net originator wins and the net terminator loses. This settlement has consequences for larger (mobile) prepaid specialists and net terminators because so many prepaid phones are terminating-only devices.

Revenue sharing arrangements (RSA) are sometimes used by carriers serving complementary markets, as a substitute for paying explicit interconnection charges. RSAs are usually the result of negotiations between operators, and generally not cost-oriented. Rather, these arrangements reflect the bargaining power of respective operators and prices are based on the relative ratio of revenues being assigned to each operator. As a consequence, efficiency of such negotiated charges typically depends on how closely operators assess their own costs.

Although useful in the fist steps of liberalization, once competition is introduced into the market, these arrangements exhibit some policy disadvantages. In Ethiopia, until mid-2004, the absence of competition in both fixed and mobile market entailed little concern for interconnection by Ethiopian Telecommunications Corporation (ETC), the incumbent. ETC negotiated the fees directly with policy makers to set the terms of interconnection. Mobile interconnection is set by ETC and not through commercially negotiated agreements. This is based on the most profitable interconnection formula with a minimum regulatory intervention.

Table 10. Interconnection Regimes: Advantages and Disadvantages

	Advantage	Pitfall	Example
CPNP	Consistent with Ramsey-type analysis assuming parties can internalize externality caused by charging only the calling party.	Incentives for regulatory arbitrage Terminating Access Monopolies issues	US CLECs until 2004
B&K	No need for terminating operator to have accounting and billing systems to monitor the flow of traffic	Creation of strong differentiation between MTM and FTM rates	France for MTM interconnection rates until 2004
RSA		Arbitrary in the setting of interconnection charges Level of Charges depends on the operators' bargaining power	Ethiopia

atterns of Interconnection Regimes

Symmetry and Reciprocity. Asymmetry in prices is usually linked to the regulatory framework sustaining the opening of competition in a given national market. For example, in the classic European framework, the incumbent fixed operator's interconnection rates are cost-oriented, and termination charges on mobile markets are a consequence of multiple regulatory trade-offs. Although in the past some operators have differentiated FTM and MTM termination rates, mobile termination has been increasingly treated as a single service.

Price symmetry conflicts with cost-based interconnection. For instance, competing mobile operators (although using the same norm) have different business plans, employ different technologies and show differences in scale, scope, market share, and traffic carried. Cost-based structures are therefore different. This explains the growing demand from mobile operators to regulators, not to set equal mobile termination charges for different networks.

On the other hand interconnection charges differing by operator can have a distorting effect on the market. In Ghana, Mobitel claimed it might be forced to exit the market due to Ghana Telecom's request for higher interconnection rates. New mobile entrants' need to develop their networks, build market share and recoup investments are the justification for regulators allowing them to charge higher termination rates.

Symmetry in price termination presents two conflicting economic arguments: economies of scale and incentives. For a given network technology and asset costs, differing unit charges might be justified for operators with different traffic volumes and/or subscribers, as they do not spread their total cost on the same basis. Yet adopting higher termination charges for newer/smaller entrants and rewarding lowest market share operators may be disincentives to market growth and may have distorting effects on competition. For operators symmetry is therefore largely strategic and will depend on their relative dominance in the market.

Guinea Bissau and the DRC are examples of different mobile networks termination rates, based on the network used to originate the call. In Senegal, recent changes to the interconnection regime have been proposed in order to move from asymmetric to symmetric termination charges on the existing mobile networks.[17]

[17] The main consequence of such a change would increase by 104 percent termination fees on the Sonatel Mobile network, and decrease by 25 percent termination fees on the Sentel network

Table 11. From Asymmetric to Symmetric Termination Charges on Senegalese Mobile Networks

In USD cents/min	Mobile To Fixed	Fixed To Sonatel Mobile	Fixed To Sentel
Before proposed change	7.40	4.88	13.35
After proposed change	7.40	9.98	9.98

Source: ART Senegal – March 2005

Asymmetric interconnection regimes have been identified as increasing the sustainability of under-serviced area operators. As markets have opened interconnection prices have become increasingly cost-based and differential costs in the provision are more transparent. Asymmetric interconnection regimes have progressively become an economic reality.

In the US and Chile,[18] the asymmetrical cost of terminating calls in high density (low-cost urban) and low density (high-cost rural) areas are now recognized. Strategically, asymmetrical interconnection charges in countries such as South Africa (see Gillwald 2002), are not (uniquely) a necessary condition to ensure the commercial viability of USALs. They are also a source of new service innovation and business opportunities, which helps to generate further revenue in under-serviced areas.

In conclusion, termination rates should not be regarded as subsidies when creating an asymmetrical interconnection regime for rural areas, as they are rather an opportunity to implement fair price discrimination and render account of the real difference in cost between urban and rural termination costs.

Direct versus Indirect Interconnection

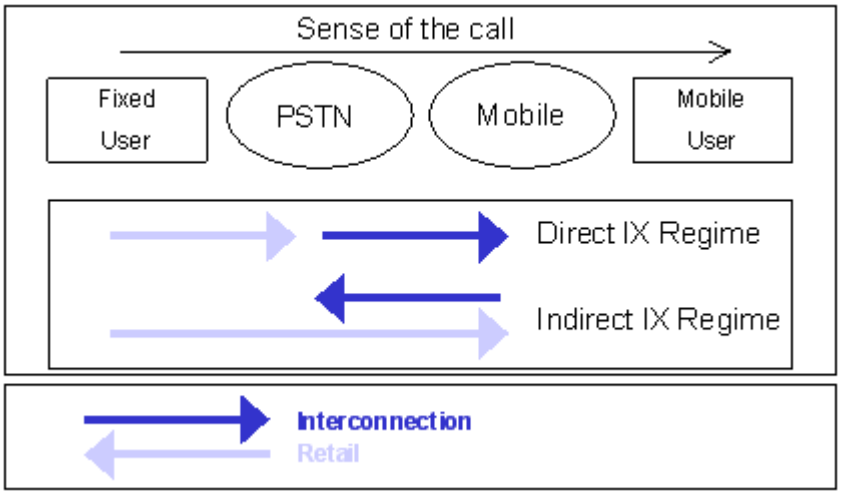
Two types of interconnection patterns can be implemented for a FTM call in the same direction. These patterns will generate different revenues sharing patterns between originating (i.e., fixed) and terminating (i.e., mobile) operators.

Inverted Terminating/Direct Model

As in the indirect model, the call is initiated in the fixed network, but the destination number belongs to the mobile operator. The originating operator bills originator final consumer and pays the mobile operator to terminate the call on its network.

[18] In an international view point, in the context of the dispute over settlements rates, the question of asymmetrical costs associated with terminating international calls in developing countries has been raised by the ITU.

Figure 3. Direct –vs– Indirect Interconnection



Originating/Indirect Model

In this model, the mobile terminating operator is responsible for the call, and bills it to the originator final consumer, the fixed originating operator is paid to collect the call and receive the origination charge. The bill is therefore the mobile operator's responsibility (which can be subcontracted to the fixed operator).

For regulators and operators the regulation of incoming calls and the choice between originating or terminating regime raises two main questions:

- *How to share revenues?* In a direct interconnection framework, the fixed originating operator pays a terminating charge to the mobile terminating operator and bills a retail tariff to the originator of the call (end-user). This situation allows the fixed operator to have a strong commercial relationship with the end-user, adapt its retail price policy to the interconnection termination (vs. origination) prices, and therefore control the rate of return of its operations.

- *Which operator needs to reveal information?* In a direct interconnection framework, the mobile terminating operator needs to charge terminating interconnect charges to the fixed originating operator. According to a number of national regulations these charges need to be *cost based* as far as the mobile operator is considered, to have a significant market power on the relevant market.

Usually in CPP countries, termination regimes apply and terminating interconnection prices are higher on mobile networks than on fixed networks. Even though cost based interconnection rules are theoretically strictly implemented by regulators, such a difference between termination fees on fixed and mobile networks should not be analyzed only as a strict compliance to costs generated by a call terminated on a fixed or a mobile network.

Table 12 illustrates how much pricing asymmetry between FTM and MTF termination interconnection is strong in Europe and how much, inherently, the retention rate19 for FTM calls largely benefit mobile operators.

Table 12. Fixed-To-Mobile Interconnection Termination Fees in Europe

Country	Cost Standard for SMP operators on interconnection	FTM/MTF	Average fixed retention for FTM calls
Austria	LRAIC	12.8	23%
Denmark	LRAIC	21.6	11%
France	LRIC + markup	20.3	13%
Germany	LRAIC	16.6	31%
Ireland	LRIC + markup	12.4	30%
Italy	FDC	19.2	18%
Netherlands	LRIC for termination	20.8	13%
Spain	FDC	13.7	26%
UK	LRIC + FDC	26.2	30%

Source: Author calculations , Legend: LRAIC- Long Run Average Incremental Costs, LRIC- Long Run Incremental Costs, FDC- Fully Distributed Costs)

Whatever the chosen interconnection regime, questions remain on how operators manage to share revenues generated with FTM calls. In Africa, although most countries are in a CPP regime, the strong pricing asymmetry between FTM and MTF interconnection charges are not as significant as those in most European market (see evidence on Table 12).

[19] Retention means the difference between the retail price paid by the customer and the interconnection price paid by the operator

Table 13. Africa, FTM to MTF Interconnection Rates (2005)

Country	FTM/MTF	Country	FTM/MTF
Botswana	6.8	Togo	1.4
South Africa	5.4	Senegal	1.3
Benin	4.3	Burkina Faso	1.3
Morocco	4.0	Cameroun	1.3
Algeria	3.0	Ghana	1.1
Tunisia	2.7	Uganda	1.1
Nigeria	2.1	Ethiopia	1.0
Gambia	1.8	Congo Brazza	1.0
Kenya	1.5	Rwanda	1.0
Mali	1.5	DRC	1.0
Guinea Bissau	1.4		

Source: Author calculations

Two characteristics need to be highlighted:

- In the mobile termination market each mobile operator (independently from its market share) enjoys a dominant position in respect to the fixed operator. However, although mobile termination fees constitute (as in all the CPP countries) a true bottleneck, some countries such as the DRC, Ethiopia, and Rwanda have adopted a perfect symmetry in termination on fixed and mobile networks.
- Weak asymmetry between terminations fees cannot be explained by an FTM interconnection fee lower than worldwide average, but rather by an MTF fee much higher than benchmarked rates. This situation also illustrates both the partial substitutability between fixed and mobile calls and the specificities of the African market.

In most African countries today, the specificities in the pricing structure of interconnection raise the following questions:

- Is competition in retail markets strong enough to provide incentives for operators to resist collusion in the interconnection market?
- Do existing regulators have the ability to develop tools to promote competition by pricing access?

Theoretical Considerations: The Impact of Market Changes on Interconnection

The development of mobile markets as an alternative access technology to fixed-line networks has transformed the organization of the industry and the approach to interconnection. In such context, interconnection issues are no longer related to one-way access in a vertical industrial structure. Rather, interconnection regimes have become two-way access issues, in which consumers calling each other belong to two different local (mobile and/or fixed) access networks. In this context, operators compete on horizontal markets that are more or less substitutable.

A common idea is that network proliferation can lead to a withdrawal in regulation as networks become symmetric. Yet, in a transition context, when a strong asymmetry exists between operators, the development of access competition to subscribers creates new types of behaviors requiring regulatory intervention.

Recent literature (Laffont and Tirole 2000) focuses on the design of two-way access policies and presents some innovative concepts on the optimal (operator) behavior towards setting interconnection charges. These considerations rely on numerous assumptions such as:

- The nature of competition between networks (level of products differentiation);
- Reciprocity or nonreciprocity in interconnection charges;
- Normative objectives pursued by the operator in setting interconnect prices (social surplus, individual or joint profit maximization, etc.);
- Pricing policy (linear versus two-part tariff);
- Discrimination between on-net and off-net calls; and
- Balancing calling pattern of on-net/off-net calls and incoming/outgoing calls.

Interconnection between Asymmetric Networks: Cost-based or Not?

Unlike fixed-line markets, mobile ones have been structured fairly quickly as duopolies or oligopolies.[20] Building transparent and competitive markets remains of primary importance. Countries practicing competition have significantly higher rates of mobile penetration than monopoly markets, even with similar levels of per-capita incomes. Although effective to some extent, competitive downward pressure on prices in the retail market has had more impact on outgoing calls (from mobile networks) than on incoming calls (to mobile networks).

[20] As in Europe, in Q2, '04 numerous African countries have third mobile operator (Kenya, Madagascar, Malawi, Uganda, Burundi, Zambia, Zimbabwe, South Africa) or more than three(Tanzania, Somalia, DRC) (source EMC).

Another important element is that mobile networks have not generally been subject to price control, either on their termination rates or on their outgoing call prices. A natural consequence is that mobile operators have charged termination rates in excess of estimated termination costs. Justifications for high mobile termination rates include revenue generation for new operators to subsidize the handset industry and offer low outgoing call rates. Nonetheless, the persistent high level of mobile termination charges and the resulting large financial transfer from fixed to mobile termination rates may have important anticompetitive consequences. Bomsel *et al* (2003), have asserted that the effect of this transfer has been to damage fixed consumers and hamper competition in the fixed market. Also, in response to this, they designed an optimal policy towards fixed and mobile termination charges aimed at redressing the imbalance. This policy sets both mobile and fixed operators on the same cost basis, eliminating existing asymmetries between cost based fixed termination rates and uncontrolled (or loosely controlled) mobile termination rates.

A closer examination of related literature on interconnection between fixed and mobile networks (Armstrong, 2002), (Wright, 2000), (Gans & King, 2000), (Seonghoonm Gyu & Chang, 1998) shows contrasting indications on the regulatory stance to take in termination cost-setting. Nonregulated mobile operators have a natural incentive to set high interconnection prices due to the market power they enjoy in the terminating market. In this sense, regulatory intervention may be necessary to ensure coordination between interconnected networks and clear monopoly double marginalization. However, revenues from incoming calls allow operators to intensify competition in the retail market (by decreasing fixed connection fees and variable usage charges). As a consequence any regulatory intervention that forces operators to set terminating interconnection charges at the level of cost may force operators to collude.[21]

Interconnection Between Symmetric Networks: Bilateral Negotiations, Regulated Pricing, or B&K?[22]

The issue of symmetric interconnection has been widely discussed in the context of international interconnection between fixed incumbent operators before the liberalization process (see Stanley 2000). In such a context, the interconnected networks do not compete in the retail final market and enjoy monopoly positions. Recent literature considers the situation in which interconnected networks may use access charges to compete in the retail market (Armstrong 1998, Laffont, Rey & Tirole

[21] Perhaps thus proving to what extent cost-based interconnect is impossible to police.

[22] In a theoretical standpoint, full symmetry assumption consists of four assumptions: symmetric cost of providing access, no entrant market power, demand symmetry on the competitive segment and cost symmetry on the competitive segment (Laffont and Tirole, 2000, p.122).

1998). The main instruction of these models is that, under certain hypotheses,[23] it is efficient for symmetric operators (in terms of demand and supply) to use bilateral negotiations to set high reciprocal termination charges. Nonetheless, in such negotiations interconnection termination charges can constitute a tool for collusion on the retail market. By charging nonregulated monopoly prices on the retail market operators can collude to maximize their joint profit, and competition in the retail market is then annihilated. A major consequence of the high risk of collusion between operators is that *ex-post* classical competition rules and regulatory intervention becomes essential, even in the context of mature competition.

Another key assumption is that of reciprocity in interconnection prices between operators. For similar networks, both on the technology and the commercial strategy sides, the reciprocity principle implies that, for the same retail network price, revenues from interconnection payments and traffic flows between networks counterbalance each other. As a consequence, relatively similar networks should have net interconnect payments close to zero. The B&K (or SKA) regime may, therefore, be considered to be optimal when applied between symmetric operators. B&K allows to substantially reduce transaction costs and to enhance social welfare (Williams 1995). Other theoretical advantages from adoption of B&K systems (Atkinson & Barnekov 2000), (DeGraba 2000) are that:

- B&K is an efficient way to share (fairly) the cost between interconnected networks, as all parts of the call derive net benefits from it;
- Operators need to recover their cost via the revenues taken from their final consumers because they cannot do so through interconnection;
- B&K levels the market playing field because operators are not primarily financed by interconnection revenues; and
- B&K minimizes regulatory costs in reducing the role of the regulator as long as competition is expanding.

In this theoretical framework, the B&K system discards the market power enjoyed by operators in the termination market.

Operational Considerations, Interconnection Issues for Mobile Operators[24]

Interconnection revenues for mobile operators in Africa represent an important part of the total turnover. In the same time, they depend on multiple factors such as :

[23] One of the most important being the balanced calling pattern.
[24] This paragraph is based on discussion with IFC colleagues and on an IFC internal work "A Note on Interconnection Issues".

interconnection charges applicable to different types of traffic, balance of traffic flows between interconnected networks, evolution of the market, and the actions and policies of the regulator. Because of the dependence on this source of revenues, and of their unpredictability, interconnection revenues have proven to be a continuous source of uncertainty in investment decisions.

How Important is Price Discrimination Between Termination on Fixed and Mobile Networks?

As noted above, interconnection charges differ according to the type of traffic. In the overwhelming majority of countries, the FTM tariff is significantly bigger than the MTF tariff. In SSA, where one-way access did not precede the two-way access regime (Bezzina, 2004), competitive and regulatory pressures did not have the same effect on interconnection termination prices.[25] This situation also illustrates the issue related to partial substitutability between fixed and mobile calls, and the specificities of the African market, where mobile networks filled the large demand unmet by preexisting limited fixed networks. This specificity seems to make network effects in mobile subscription a driver for the substitution effect.

The direct consequence of the large difference between MTF and FTM interconnection charges is that, *ceteris paribus*,[26] this will result in a net payment by the fixed operator to the mobile operator. Naturally, the actual flow of payment will be determined by the balance between inbound and outbound traffic.

Table 14 (see following page) provides details of the levels and structures of interconnection charges in African countries, showing the extent to which pricing configurations and price discrimination differ between countries.

What is the Balance of Traffic?

Although central to the design of the business plan, traffic flows between different networks cannot accurately be predicted. This observation is supported by the substantial changes experienced by the evolution of traffic and calling opportunities between fixed and/or mobile networks, as the degree and maturity of competition and line penetration changes.

[25] It can also be sustained that the discrepancy between FTM and MTF termination rates can be explained by the difference between technologies used in the two networks and widespread adoption of the Long Run Incremental Cost (LRIC) to assess termination rates. A fixed (resp. Mobile) network faces higher (resp. lower) fixed cost and lower (resp. higher) variable costs.

[26] *Ceteris paribus* means, "assuming that an equal volume of traffic is exchanged between fixed and mobile networks."

Table 14. Mobile-To-Fixed and Fixed-To-Mobile Interconnection Rates in USD cents per minute (Peak) in Africa in 2005

Country	MTF Local	MTF ST	MTF DT	FTM	Departure from the average
Algeria	1.68	3.36	3.92	9.1	-28%
Benin	5.59	5.59	5.59	24.23	92%
Botswana	2.35	2.35	2.35	16.05	27%
Burkina Faso	3.35	11.55	11.55	11.18	-11%
Cameroon	10.44	12.67	16.96	16.77	33%
Congo (Rep.)	15	15	15	15	19%
Ivory Coast	6.52	22.36	22.36	13.04	3%
Gambia	6.43	6.43	6.43	12.86	2%
Ghana	7.06	7.06	7.06	7.96	-37%
Guinea Bissau	6.34	6.34	6.34	8.95	-29%
Kenya	9	20.58	20.58	24.69	96%
Mali	3.38	12.3	12.3	13.75	9%
Mauritania	2.26	25.65	25.65	11.32	-10%
Morocco	1.46	4.26	6.17	16.02	27%
Nigeria	4.14	4.14	4.14	8.64	-32%
Rwanda	4.8	4.8	4.8	4.8	-62%
Senegal	4.4	9.69	13.21	2.76	-78%
South Africa	4.26	4.26	4.26	22.1	75%
Togo	7.45	7.45	7.45	10.25	-19%
Tunisia	1.45	4.26	6.59	11.08	-12%
Uganda	4.67	5.19	8.31	5.19	-59%
Average	**5.32**	**9.48**	**10.27**	**12.62**	

Source: Author calculations
Legend: ST- Single tandem, DT- Double tandem

Voice traffic in France (Table 15) is a good example of this unpredictability. Here the balance of traffic did not result in higher FTM traffic flows than MTF, although the size of mobile networks' customer base has surpassed that of fixed networks. Yet, the dramatic increase in MTM traffic shows that pricing policies by mobile operators have succeeded in maximizing the mobile peer group effect and to attract consumers in communities of interest.

Table 15. Evolution of Fixed and Mobile Traffic in France

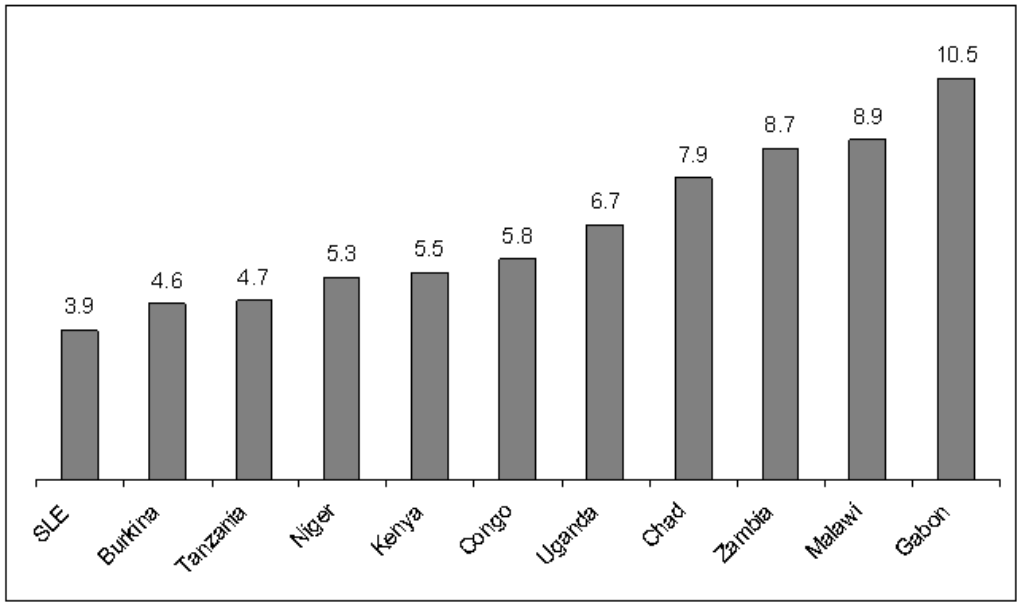
	1999	2000	2001	2002
FTM (%)	14	10	10	9
MTF (%)	50	42	37	34
MTM On Net (%)	21	30	34	36
MTM Off Net (%)	15	18	20	22
Mobile Lines*	20.6	29.6	37.0	38.5
Fixed Lines*	33.9	34.1	34.1	33.9

*Source: ART * in million by end of year*

Currently no valid[27] mathematical modeling of the evolution in the traffic repartition between networks can be achieved. For instance, it is noticeable that the relative size of a network may not influence the overall balance of traffic flows. Theoretically, an operator with X percent market share could, statistically, be making X percent of outgoing calls and receiving X percent of incoming calls. In the real world, however, numerous factors (such as being first to market), distort this hypothesis.

An estimate of the repartition between outgoing/incoming national traffic (Table 16) shows how dramatic an imbalance persists in favor of incoming calls. On average, the incoming traffic flow is more than six times the outgoing national traffic flow.

Table 16. Estimated ratio between Incoming and Outgoing traffic in 2004: the Celtel Case



Sources: Celtel and Author calculations

2.2 Interconnection Regulation in Converging IP-Centered Environment

The Shift in the IP Network Paradigm: Policy and Market Implications

Recent technological development—most recently, the advent of transmission using IP—has generated a multiplicity of new information communication technologies (ICT) services and applications. The time is over when each service matched a specific form of infrastructure and regulation—networks multipurpose use blurs regulatory boundaries, particularly as regards interconnection.

[27] A fundamental statistical assumption would be that every subscriber in every network is just as likely to call any other customer in any network and just as likely to receive a call from any other customer.

In the plain old telephone network (POTS), the intelligence is located centrally (the switch) and controlled frequently by one stand-alone organization: in such a configuration, traffic flows to and from exchanges are routed in a bilateral way. By contrast, in the IP world, the intelligence is deliberately designed at the edge of the network. In this configuration, traffic is routed as soon as it can find the easiest route and thus not always via a central point. As a result, IP networks have the opportunity to change the network structure's paradigm. Due to innovation and decentralization of intelligence in the system, the old structure of "small-number-of-large-organizations" is no longer the only option. This opens opportunities for the creation of extremely diverse ecosystems. Technological changes and the use of IP networks allow new business models to grow at the edges of the networks by allowing local/small scale level plug-and-play operators to interconnect with much larger operators.

Technological changes and convergence in voice, video, and data transmission are making interconnection issues more important and more complex than ever. In most African countries, in the wireline world, VoIP looks set to replace existing forms of telephony (to a lesser extent, this is also the case with the introduction of GPRS and 3G in Kenya, Mauritius and South Africa). Although recently unsustainable regulatory rules made VoIP illegal, the grey market using such a technology has reached 30 to 50 percent of international voice traffic. While mobile operators' networks can meet the existing voice demand, they might be significantly less able to interconnect medium- and long-term data demands.

VoIP has the power to potentially transform telephony in Africa. Entry of IP telephony service providers, whether legal or illegal, in the domestic markets has facilitated the acceleration of the market liberalization pace and the introduction of competition in the long-distance and international service markets. The general approach of prohibition adopted in Africa is at best short sighted, and at worst, a deterrent for innovation, competition, and overall consumer welfare.

One important technical/market feature of VoIP relates to measuring traffic. In a packet- switched world, no dedicated voice minute traffic exists: packetized voice and data services traveling over the same medium are virtually indistinguishable. This makes it impossible to separate measurement and usage of voice and data services.[28]

[28] This statement needs however to be put in perspective. Originating operators still charge their clients in minutes, as do terminating operators. The use of IP simply makes the transit portion less costly and more efficient. Call Detail Records (CDRs) are still generated and settlement still seems to be based on these records, rather than on capacity utilized. Note also that, with the use of Multi-Protocol Label Switching (MPLS) and Session Initiation Protocol (SIP), it is possible to identify voice packets separately.

Table 17. Examples of Regulatory Status in Africa

Country	Latest development in the regulation of VoIP
Kenya	▪ Telkom Kenya has disconnected individuals and business using Voice over Internet Protocol (VoIP) calling cards from making international calls. ▪ Consultation closed on 28 February 2005 ▪ March 2005: CCK ordered Telkom Kenya to restore the VoIP suspended in february. ▪ Provision of VoIP services by ISPs and other operators is no longer illegal.
Nigeria	▪ Regulate services, allowing operator choice of technology ▪ International access to be liberalised, with operators required not to discriminate on interconnection and transit ▪ Type approval of equipment
South Africa	▪ infrastructure limited to Telkom, SNO (Tata) and MNOs ▪ Ministerial direction made VoIP legal from 1 Feb 2005

From a regulatory point of view, services provided by IP networks are challenging traditional subsidy mechanisms: domestic and international interconnection, universal services, usage and distance based charging mechanisms lose their applicability for packetized traffic. In this convergent environment, regulators need to modify traditional interconnection rules and regulations in order to cope with new market specificities. The extent of the impact of convergence on interconnection rules is demonstrated by the pressure exerted on regulators by ISPs, consumer groups, and pro-Internet lobbyists to modify the rules of the game.

Dial-up Internet access prices differ from classic voice telephony tariffs in terms of level (lower interconnection rates for internet traffic versus voice traffic), and especially in terms of structure (unmetered, flat-rate Internet access packages for ISPs). Table 17 provides the comparison between interconnection charges in circuit-switched and packet-switched networks.

Table 18. Interconnection Charges: IP and Circuit-switched

Interconnection charges	Circuit-switched networks	Internet (IP)
Termination traffic	Charge per minute	No charge between IP networks of the same size Large ISPs charge small ISPs on the basis of the bandwidth of the interconnection link
Transit traffic	Charge per minute	Charge on the basis of the bandwidth of the interconnection link
Interconnect link	Cost sharing on Causation basis	Smaller IP networks normally bear the cost of the link in full

Source: OVUM (The business case for Next-generation IP Networks)

Three Selected Issues

Which interconnection mandate for which network? In a traditional environment public switched network operators (whether fixed or mobile) have an obligation to interconnect with each other. In addition, for the principle of network asymmetry, interconnection rules are not universally applied to all types of networks. Finally, regulators put additional regulatory burdens on operators with significant market powers in relevant markets.[29]

In a converging world, where voice, data, and video become a common market, the main issue is determining which operator should be allowed and/or required to interconnect. Traditionally interconnection mandates for different networks were specified through licensing classifications (e.g., individual licenses as opposed to general authorizations, as opposed to services providers without a license). Interconnection rights and obligations depend on the classification of services and service providers. Contrary to traditional (fixed and mobile) voice providers, VoIP providers are not subject to obligations such as minimal service funding and tariff filing. However, these services threaten the scope, scale, and the basis of existing interconnection pricing models.

How can interconnection regimes be technology-neutral? Technology-neutrality (i.e., recognition that real-time interactive voice telephony is the same, irrespective of which technological platform is used to carry it) has been considered to be a fairly good licensing option in a converged environment. Neutrality ensures a fair and predictable regulatory regime, flexible enough to embrace technological changes and market developments. The question of how to adopt a technology-neutral interconnection regime, in the context where IP-based networks are becoming the main voice traffic carriers, is of growing importance for regulators. Diffusion of IP telephony raises dramatic interconnection payments issues. In a classic direct regime interconnection payments are possible because of the regulatory requirement of cooperation between origin, transit, and termination operators. In a VoIP context, levying different levels of interconnection charges may simply not be possible for terminating operator due to the use of virtual numbers and difficulty to locate the origin of the call.

How to deal with new cost structures and levels? The change in technology from circuit-switched to IP-based networks may also affect the cost of providing and running networks. Consequently, regulators must be aware of new cost struc-

[29] See for example the European Union 2002 Access Directive updating the EU's 1998 regulatory framework.

tures and will need, if they don't consider moving to something like capacity-based interconnection rules, to revise the figures they determine (and the basis of their determinations) to take into account the change in the nature of the networks. Table 19 illustrates the differences between interconnection in the circuit-switched and Internet (packet-switched) networks.

Table 19. Interconnection Differences Between Circuit-switched and IP

Interconnection Aspect	Circuit-switched interconnection Approach	Internet interconnection (IP) Approach
Core transit network	National Incumbent	United States backbone operators
Regulation of interconnect supply conditions	Strong regulation of the incumbent: e.g., incumbent must charge cost-based prices for unbundled services	None
Publication of interconnect charges	Required for interconnect with incumbent	None
Control of network boundaries	Gateway for charging and security functions	Very limited
Location of POIs	Agreed on bilateral basis	Increasingly telecom hotels
Charging arrangements	Charge per minute	No charges, or charges based on bandwidth of interconnect link
Principles underlying charging arrangements	Cost-causation	Cost and value of interconnect to each party
Is Call Detail Record provided?	Yes	No
Possible to distinguish traffic by origin?	Yes	No[30]

Source: from ITU 2003

IP telephony may also have dramatic impacts by reducing the costs of providing voice telephony services. Technology is steadily decreasing the cost of networks while the costs of billing and customer service may be reducing more slowly, creating strong pressures for reduction in retail prices. As a result, operators of old technologies (public switched telephone network [PSTN]) may be obliged to

[30] This statement may be contested in appropriate protocols.

undertake unanticipated write-offs of the value of their existing assets. In African countries, this issue might be as relevant as many new entrants are already IP-centric (i.e., use IP in their core backbone networks), as opposed to incumbents that are only starting to move away from their legacy systems and upgrade to IP-based backbones.

The Case of IP Telephony and VoIP[31]

In Africa (more than anywhere else), the introduction of IP telephony is challenging the economics of international voice communications. In most markets where international calling rates remain high, estimates suggest that IP telephony traffic constitutes approximately 10 to 20 percent of the overall market (see Cohen and Southwood, 2004). In regulatory terms, this issue divides regulators in two groups: those trying to ban it, and those preferring to ignore it by leaving it unlicensed. Table 20 shows the status of IP telephony in Africa.

Table 20. Status of IP Telephony Markets in Africa

% of countries	IP Telephony Status	Notes
16	No policy for IP telephony	The respondent did not answer this specific question or indicated that there was no current policy, or that a new policy is currently being formulated
8	Full Competition	All PTOs, whether licensed or not, may use both IP-based networks and the public internet for the conveyance of voice calls
16	Partial Competition	Non-licensed PTOs may use either IP-based networks or the public Internet for the conveyance of voice calls
22	Prohibited	All PTOs (even licensed ones are prohibited) from using IP-based networks or the public Internet for the conveyance of voice calls
38	Restricted	Only licensed public telecommunication operators (PTOs) are able to use IP-based networks or the public Internet for the conveyance of voice calls

Source: Responses to the 2004 ITU Regulatory Survey concerning the regulatory status of IP telephony

[31] IP telephony refers to any telephone-type service carried over IP (i.e., VoIP, faxing or text messaging) While VoIP is voice over IP only.

Due to the withdrawal of traditional carriers, a significant shift has occurred in the wholesale international voice market for IP telephony and VoIP; as a result, a number of nontraditional) global wholesale carriers have appeared.[32] In Senegal 40 percent of Sonatel's inbound international voice traffic is carried over VoIP. Table 21 shows the decline from 2002 onwards in the total number of circuits to ECOWAS countries provided by US international facilities-based operators.

Among the numerous challenges raised by IP telephony for traditional interconnection arrangements the following three emerge:

- Should interconnection with traditional operators be permitted or required?
- How should access to international gateways be organized (particularly with incumbent monopoly persisting in many African nations)?
- What are the implications of choosing different numbering schemes for interoperability and interconnection between PSTN and IP networks?

Table 21. Variation in the Total Number of Circuits to ECOWAS Countries Provided by US-based Operators Between 2002 and 2003

	Change in number of circuits
Benin	-31%
Burkina faso	-4%
Cape Verde	0%
Cote d'Ivoire	-53%
Gambia	-25%
Ghana	-43%
Guinea	-14%
Guinea Bissau	-100%
Liberia	-53%
Mali	-52%
Niger	-100%
Nigeria	-43%
Senegal	-73%
Sierra Leone	-16%
Togo	-57%
Total	-45%

Source: From FCC International Bureau, Circuit Status Data Report December 2004

Existing practice provide little definition to the optimal policy choice (Table 22 - following page) or to the global trend likely to provide guidance to developing countries.

Over the last few years, African regulatory agencies have become inclined to accept the principles of technology-neutral regulation.[33] For example, in 2004, South Africa announced (as part

[32] In the ECOWAS region among the new global wholesale carriers we find: Gateway Communications, iBasis, ITXC.

[33] Based on the belief that, whatever the technical platform used to carry it, real-time interactive voice is the same product.

Table 22. Benchmarking policy for IP telephony

Country	IP Telephony Policy
Barbados	Telecommunications Act - licensees that provide telecommunications voice services to the public are required to have interconnection agreements in place. These requirements must also apply to any new ITSPs.
Hong Kong	Local access charges apply to IP services provided using the PSTN; Rate setting pending.
Ireland	Direction to incumbent to allow one initial price point for VoIP interconnection – rates set by regulator.
Israel	No access charges for delivering VoIP services over third-party broadband lines for international services; April 2005 Bezeq seeking a one-off fee of NIS 500,000 from operators wishing to participate in VoIP market trials.
Korea	Regulator sets rates; considering a revenue sharing model for interconnection payments.
Malaysia	Review of access and tariff provisions associated with VoIP services, in a bid to reduce dependence on foreign gateways.
Norway	Considering incumbent obligation to offer interconnection to IP telephony at cost-oriented rates.
Philippines	Draft rules mandate interconnection agreements - network providers must provide equal access and the same prices for substantially similar services to VAS providers.
United States	Phone-to-phone services – interstate access charges apply Lower, reciprocal compensation rates for 'information services'.

Source: Yankee Group

of its general market reform) a partial liberalization of IP telephony in under-served areas, in advance of the introduction of a second national fixed operator. The Communications Commission of Kenya, through its post-exclusivity regulatory strategy, also adopted a technologically-neutral regulatory framework facilitating the use of IP based technologies including VoIP. The implementation of this framework will allow licensed infrastructure providers such as Internet backbone and gateway operators, broadcast signal distributors, commercial very small aperture terminal satellite operators, and public data network operators, to carry any form of multimedia traffic including IP traffic (for example VoIP).

In terms of interconnection, the growing use of IP telephony by incumbents (to recapture international traffic lost to the grey market) to reduce transmission and switching costs over expensive satellite circuits, would allow the lowering of interconnection costs by originating and terminating IP telephony minutes. For example, in Senegal, in 2001 and 2003, Sonatel signed interconnection agreements with international wholesale carriers (with, respectively, ITXC and Gateway Communi-

cations) to terminate VoIP calls and offer low cost international calling services. The Kenyan Telecom incumbent, Telkom opened negotiations with ISPs in order to allow them to terminate VoIP calls.

Are Regional IXPs Between ISPs A Solution?

Growing pressure aims to bring the international accounting rate system in line with better suited interconnection arrangements for competitive markets. As a result, expecting that regulation will straighten the imbalance in the distribution of the costs of international connectivity between African Internet backbone and international Internet backbone providers is not a viable solution. The pressure for changes in accounting rate systems is derived from global market evolution, with termination charges for international traffic driven by market forces rather than bilateral negotiations. In this context, addressing the African problem of high connectivity costs will likely be driven by the private sector. As an example, a strategy such as The Halfway Proposition presented by African ISPs in a background paper on reverse subsidy auctions of G8 countries. This proposition was oriented toward a cohesive plan involving two specific steps: the creation of a Traffic Aggregation Point within Africa, and the creation of digital highways to carry the traffic.

Africa's Internet needs improved interconnection among ISPs. Without direct ISP-to-ISP interconnection, each ISP must send all its outbound traffic[34] to Europe or the US via satellite, only to have it routed right back. Moreover, due to their relatively small size, African ISPs can buy only costly transit services from international satellite and backbone providers to carry the traffic they can't exchange via local interconnection and peering with their competitor ISPs. *Some of the main reasons for the lack of Internet reliability, its bad quality of service, and its the high price are the lack of local interconnection, peering, and at the end of the day, the lack of competition.*

The creation of regional IXPs[35] in Africa is considered a sound strategy, both to create opportunities for the emergence of regional carriers facilitating regional peering/continental transit, and to promote the development of cross-border links and intercountry infrastructure. IXPs are the interconnection points of the Internet—the places where ISPs come to interconnect with each other. Implementing such a clearing house for Internet traffic at the regional level offers the following

[34] Including traffic destined for other ISPs' customers in the same country.

[35] An IXP is a physical infrastructure that allows different ISPs)to exchange Internet traffic between their autonomous systems by means of mutual peering agreements. IXPs are typically used by ISPs to reduce dependency on their respective upstream providers; furthermore, they are used to increase efficiency and fault-tolerance.

Box 1

Interconnection Clearing houses and Telecom Hotels

Convergence has led to a rise in the number of operators and, consequently to an increase in the number of interconnect links. The creation of an interconnect clearing house has recently[36] been identified as a possible solution to manage multiple operators and interconnection complexity. This solution is expected to replace the current traditional interconnection regime based on bilateral agreements to make interconnection exchanges versatile enough to accommodate all type of interconnecting links in accordance with licensing or regulatory requirements.

Interconnection within the Internet increasingly occurs at telecom hotels facilities which provide the sophisticated infrastructure critical to housing equipment for switch, colocation and other telecom-related needs. A telecom hotel can be defined as a site where several communications services could house network equipment and link more easily to one another. Telecom hotels provide access to regional, national, and global telecommunication backbones. In contrast with physical POIs for interconnection arrangement between traditional circuit-switched networks, the ISP interconnects on a bilateral basis, or through an Internet exchange on a multinational basis.

advantages: (a) it reduces expensive cost to use upstream provider to exchange local traffic over transcontinental link and (b) it reduces delays and latency for IP traffic exchange and improves performance.[37] National and regional IXPs could dramatically lower the amount of national and intercontinental traffic that need to leave the continent.

From an economic perspective, the creation of a mesh of point-to-point interconnected African IXPs and the implementation of continental interconnection within Africa, would enable ISPs to benefit from economies of scale in aggregating inter-African traffic and negotiating better transit prices from the global backbone providers.

Regulatory and competitive issues derive from the need for ISPs to provide their own backhaul link and router to plug into the IXP in order to deliver and receive local traffic. Ideally, participating ISPs should own and/or operate their infrastructure to the exchange, but in those countries where regulation does not allow ISPs to own their own backhaul link, they are obliged to lease this capacity from licensed operators.[38]

Regardless of the technical difficulties to establish direct point-to-point links between IXPs, the issue remains one of breaking-even in a cost-benefit framework.

[36] See ITU-D Study Group 1 (Question 6-1/1 on Interconnection).
[37] As an example, in Kenya, the average latency on packets between ISPs using normal circumstances is between 1200-2000ms due to multiple satellite hops in between as the packets go from continent to continent on their way back to Kenya. On an uncongested link to the IXP, the latency is between 30-60 ms.
[38] In the case of Uganda, the second national operator (SNO) MTN has leased some of its fibre capacity to ISPs who could not afford to lay their own connection.

Currently the inter-African traffic is not sufficient for a given ISP to conclude that the net advantage between the proportional share of the cost of the link between IXPs and the financial benefit of peering across it is greater than the average pro-rated cost of a direct point-to-point satellite. In other word, "*The cost of interconnecting countries will not fall below a certain level until more countries are connected by fibre and there is open competition for fibre provision. Where there is sufficient traffic to justify it, fibre is undoubtedly cheaper than satellite, although the latter will remain the best way of reaching Africa's widely scattered population.*" (Via Africa, 2004).[39]

3. Conclusion and Policy Implications

Interconnection regulation in Africa has been defined at the onset of the mobile uptake and of the technological changes leading to convergence between transmission of voice, data, and video traffic.

Today, in a context of increased competition and convergence, most African countries have mobile penetration dramatically overtaking fixed-line services and a lack of significant regional and international transmission infrastructure hampering their ability to exchange Internet traffic. This situation brings serious disadvantages in terms of cost savings, access, speed, and latency.

Other issues specific to SSA are the lack of a cost-based tariff system, along with discrepancies between different operators' traffic measurements.

3.1 Three Key Issues to Address

The growth of VoIP traffic is highly dependent upon the high levels of international backbone prices. Consequently, the way in which the majority of African countries will eliminate their monopoly in international backbone markets will determine the extent to which international voice traffic will drift toward cheaper VoIP alternatives. Prohibition to use VoIP is still in force in some African countries, but the ability to enforce it is negligible. In this respect, control of international gateways is less and less relevant and sustainable. Moreover, attempts to ban services have been largely ineffective and determined the proliferation of gray markets in many developing countries.

[39] Question remains however to know wether there is actually enough traffic to justify competition between fibre operators. Also, due to the tremendous capacity of fibres, marginal cost for an existing fibre operator to provide service to additional customers is low so that no new entrant may have difficulty to compete in price.

Emerging global trends in VoIP regulation indicate that: (a) the regulatory treatment of VoIP is not yet clearly defined, and (b) there is no guarantee that the relatively hands-off global regulatory status quo will prevail. As the classification and subsequent regulatory treatment of IP services are progressively emerging on regulatory and judicial agendas, our recommendations indicate a set of emerging issues to be addressed by regulators and policy makers:

- Where to intercept the call data (access provider network, ISP, gateway provider, terminating operator network)?
- Should B&K models prevail as in the Internet world (peering) and is Calling-Party-Pays still an efficient model?
- Should IP telephony providers be subject to interconnection obligations, in which cases, and should they pay retail or wholesale interconnection rates?

3.2 The Need for IXP

In Africa, and in particular in the francophone ECOWAS region[40], the Internet is not yet a driver of intraregional traffic. The lack of IXPs is an indicator of the weak volume of direct Internet traffic between countries. Also, VoIP traffic between Personal Computers in the region still needs to rely on international Internet networks. In order to avoid the growing routing of VoIP traffic via Europe or the US and back, the establishment of IXPs in the region is urgently required. In a second stage, the preconditions for peering between ISPs within the region will rely on the presence of regional transmission infrastructure, allowing the development of cross-border infrastructure to facilitate access to long-haul submarine fiber link.

To overcome the lack of peering and the use of expensive transmission media that leads to inefficiency in terms of resource utilization and adds significant costs to the operations of ISPs (which are ultimately passed onto the consumer through higher prices for Internet traffic), it is proposed to use IXPs to aggregate and keep traffic local. As major results network efficiency will be improved, and latency reduced.

[40] Remember that there are currently no IXPs in francophone West. Looking at the ECOWAS region as a whole, presently all Internet traffic between ECOWAS countries transits via Europe or North America – there are no regional linkages, hubs or Exchange Points. Similarly, in regard to national Internet interconnectivity, there are no functional *national* IP exchanges as yet in ECOWAS.

A regional project could propose a strategy for the development of IXPs in the ECOWAS region, involving four major steps:

1. Analysis of the potential opportunity of IXPs and RXPs in the ECOWAS region. This phase would involve carrying out a study to assess the potential opportunities for deploying national and regional IXPs in the ECOWAS region;
2. Provide regulators and policy makers tools to showing how to remove legal/ regulatory/policy obstacles to the deployment of IXPs. A toolkit building on the aforementioned study would be developed to provide questions and answers on the main regulatory issues introduced by IXPs and RXPs, including licensing, interconnection, and the impact on local economy and business;
3. Organize educational workshops that bring together government officials, academics, ISP executives, technical experts, and others to examine the legal, regulatory, political, and technical issues surrounding IXP deployment. Workshops would provide the opportunity to disseminate the concept to a larger audience, and would also create opportunities for the emergence of a local champion to implement the concept.
4. Assist neutral, nonprofit ISP associations in their efforts to establish IXPs. This process would culminate in the establishment of priority IXPs in countries showing readiness for such a step. Several institutions and programs have been supporting the establishment of IXPs in Africa that need to be tapped and coordinated.

4. References

African Internet Service Providers Association (AfrISPA), 2002, *The Halfway Proposition*, Background paper on reverse subsidy of G8 countries by African ISPs, Conference of African Ministers of Finance, Planning and Economic Development, Johannesburg, South Africa, 19th October 2002.

Armstrong M., 2002, "The Theory of Access Pricing and Interconnection", in M. Cave, S. Majumbar, I. Vogeslang (Eds) *Handbook of Telecommunications Economics*, North Holland.

Autorité de Régulation des Télécommunications, 1999, Décision n° 99-197 de l'ART *en date du 1er mars 1999 se prononçant sur un différend entre la Société Française du Radiotéléphone et France Télécom relatif aux conditions d'interconnexion pour les appels entrants sur le réseau de la Société Française du Radiotéléphone*

Agence Nationale de Réglementation des télécommunications, 2000, Décison du Comité de gestion de l'ANRT relative au litige d'interconnexion entre entre Médi Télécom et Itissalat al Maghrib du 22 mars 2000

Agence Nationale de Réglementation des télécommunications, 2002, Décision du Comité de gestion de l'ANRT relative au litige d'interconnexion entre Médi Télécom et Itissalat al Maghrib sur la méthode de facturation du trafic de l'interconnexion du 14 janvier 2002.

Armstrong M., 1998, "Network Interconnection in Telecommunications", *Economic Journal*, 108, May, pp. 545-564.

Atkinson J. M. & Barnekov C. C., 2000, "A Competitively Neutral Approach to Network Interconnection", Federal Communications Commission, *OPP Working Paper* No. 34, Dec. 2000.

Bezzina J., 2004, "Does Dominant Regulatory Telecom Model Fit With African Specificities?, Discretion in Forward –Looking Cost Based Pricing of Interconnection", *Communications & Strategies*, No. 55, 3rd quarter 2004, pp. 77-118.

Bomsel O., Cave M., Le Blanc G. & Neumann K. - H., 2003, *How mobile termination charges shape the dynamics of the telecom sector*, study - conducted by Cerna, the Warwick Business School and WIK-Consult and sponsored by COLT Telecom and Cable & Wireless**.**

Cohen T. & Southwood R., 2004, *An Overview of VoIP Regulation in Africa: Policy Responses and Proposals*, Report for the Commonwealth Telecommunications Organisation, project funded by the UK Department of International Development (DFID), 2004.

Conseil de la Concurrence, 2004, *Avis n 04-A-17 du 14 octobre 2004 relatif à une demande d'avis présentée par l, Autorité de Régulation des Télécommunications en application de l'article L. 37-1 du code des postes et télécommunications*.

DeGraba P., 2000, "Bill and Keep at the Central Office As the Efficient Interconnection Regime", Federal Communications Commission, *OPP Working Paper* No. 33, Dec. 2000.

FCC, 2001, *Developing a Unified Intercarrier Compensation Regime*, Notice of proposed Rulemaking, April 19, 2001.

Gans J. & King S. (2000), "Regulating Termination Charges for Telecommunications Networks", *Working Paper*, University of Melbourne.

Gillwald A., 2002, "Under-service Area Licenses in South Africa: Steps to achieving viable operators", *Link Policy Research Paper Series* No. 3, LINK Centre, Witwatersrand University, February 2002.

International Telecommunication Union, 2003, *The Essential Report on IP Telephony* by the group of experts on IP telephony / IUT – D, ITU E – Strategies Unit

Laffont J. J., 2005, *Regulation and Development*, Federico Caffè lectures, Cambridge University Press, Cambridge, United Kingdom.

Laffont J. J. & Tirole J., 2000, *Competition in Telecommunications*, The MIT Press, Cambridge, Massachusetts, London England.

Laffont J. J., Rey P. & Tirole J., 1998, "Network Competition I: Overview and Non Discriminatory Pricing", *RAND Journal of Economics*, Vol 29, No 1, Spring, pp. 1-37.

Seonghoon J., Gyu Ho W. & Chang-Ho Y., 1998, Interconnection between Land and Mobile Networks, *Paper presented at the 12th Biennal ITS Conference*, June 21-24, Stockholm, Sweeden.

Stanley Kenneth B., 2000, "Toward international settlements reform: FCC versus ITU rates", Telecommunications Policy, 10/11 : 843-863.

Via Africa, 2004, *Creating Local and Regional IXPs to Save Money and Bandwidth*, Draft discussion paper prepared for IDRC and ITU for the 5th annual global symposium for regulators, IDRC, ITU, December 2004.

William s P., 1995, "Interconnection Prices in Local Telephony: The Implications of Symmetry", *Industry Economic Conference*, Melbourne, 6-7 july.

Wright J. (2000), "Competition and Termination in Cellular Networks", mimeo, University of Auckland.