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Impact of IXPs – A review of the experiences of Ghana, Kenya and South Africa

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Introduction

Those promoting the use of IXPs in a developing world context (particularly in Africa) have made three main claims for their impact when fully implemented:

1. They enable cost-savings to be made as a larger proportion of traffic is exchanged using local rather than international bandwidth;

2. They improve access speeds for users and cut down delays in downloading (through reducing latency);

3. They create revenue opportunities because they allow easier hosting of local domains and improved access speeds make certain types of applications possible.

The purpose of this research commissioned by OSI was to look at the evidence for these three different kinds of impact. In addition, the researchers have looked at a fourth type of impact: whether the cost-savings IXPs may or may not have made helped local ISPs to pass on price changes to the end-user.

A great deal of money has been spent supporting both local and regional IXPs and the purpose of the study is to provide an independent view of the kind of impact that local IXPs made, both intended and unintended.

The proportion of local traffic going via a local IXP varies from 10-50%, depending on the scale of the market involved and the level of development in that market. Therefore three African countries were selected that fell at different points of development along this spectrum.

At the most developed end of the countries selected is South Africa and at the least developed end is Ghana whose IXPs were set up some while later than the other two countries involved in this study. Kenya has been chosen as the country to represent those African countries in the middle of the volume of traffic spectrum.

The researchers were asked to use a combination of desk research and face-to-face interviews to:

- To look at whether the implementation of local IXPs has created cost savings for ISPs and whether these cost savings have been passed on to end-users. Where data was available, the researchers looked at the pattern of end use access prices from ISPs and cyber-cafes over a five or ten-year period, depending on the number of years the local IXP has been in place. These retail prices were placed alongside falls in wholesale prices over the period chosen.

- To investigate the current differences in access speeds to local Internet content and for the sending of local e-mails and where possible to

gather historic data of access speeds prior to the implementation of the local IXP.

- Using both quantitative and qualitative benchmarks, to discover whether the local content and applications sector has grown appreciably since the local IXP has been implemented. Quantitative benchmarks included: growth (or decline) in locally hosted domains, increase in the number of local companies in the sector, the growth of turnover of local companies in the sector and evidence of increased use of service and applications facilitated by the local IXP.

These impacts were to be set in the operating context within which ISPs have been operating in the period under examination. Therefore the researchers also looked at the external factors that might also have influenced the kind of changes being tracked by this research.

These included: falls (or increases) in the market price of international connectivity (particularly SAT3 prices in Ghana and South Africa and satellite prices in Kenya); improvements in local connectivity; changes in regulation; and any other external factors that might have some bearing on the impacts described above. The researchers have also sought to draw out any of the related kinds of impacts the local IXPs have had that are not captured in the subject areas outlined above.

The core of this report are three case studies covering Ghana, Kenya and South Africa. These reflect different geographic parts of the continent and also very different market sizes. The case studies are structured around a common framework:

The background to the setting up of the IXP: This section provides a description of who was behind the setting up of the IXP or IXPs and why they were set up.

Impact of IXP on pricing of the Internet: This looks at the primary question of what impact the IXP had on wholesale and retail pricing of the Internet in the case study countries.

Other impacts (speed of access, traffic volumes and local content): This section examines other non-monetary impacts like the lowering of latency, improved local network efficiencies through increased traffic volumes at the IXP and the encouragement of local hosting and content.

The impact of other factors on pricing: This examines the range of other factors that have had an impact on the pricing of the Internet other than IXPs.

The key findings from the case studies follow this section and they are used to tease out the nuances of different things that have happened as a result of the implementation of IXPs in these three countries.

We would like to thank the following research contributors for the case studies which provide the core of this report: Charles Amega-Selorm, Internet Research (Ghana); Muriuki Mureithi, Summit Strategies (Kenya) and Dobek Pater, Africa Analysis (South Africa).

Overview of research findings

The concept of Internet exchange points is built around interconnecting Internet Service Providers (ISPs and Network Operators) at one point, exchanging traffic destined for local services providers connected to the exchange point locally without needing to use expensive international link capacity.

There are currently 19 IXPs[1] operating in Africa. So how did this growth in African IXPs come about? In October 2002, The African Association of ISPs, AfrISPA published an influential policy paper called The Halfway Proposition. This highlighted the high cost of international bandwidth as one of the causes of high prices for African Internet users.

As its authors observed:"When an end user in Kenya sends an e-mail to a correspondent in the USA, it is the Kenyan ISP who is bearing the cost of the international connectivity from Kenya to the USA. Conversely when an American user sends an e-mail to Kenya, it is still the Kenyan ISP who is bearing the high cost of the international connectivity, and ultimately the Kenyan end user who bears the brunt by paying higher subscription costs."

Worse still, much of the e-mail and Internet traffic locally within an African country was transited via London or New York using expensive international bandwidth before arriving at its local destination. The authors of the paper argued pragmatically that Internet Exchange Points would dramatically lower the amount of national traffic that needed to leave the continent.

Three main arguments were made for the implementation of IXPs[2], over and above the obvious technical network efficiencies they would bring about. Firstly, they would bring about cost savings as local bandwidth was cheaper than international bandwidth. Secondly, by reducing the number of "hops" traffic had to make, they would cut down latency and improve access speeds. Thirdly, they would encourage local hosting and content.

The case studies below were designed to review whether these arguments turned out to be correct in practice but also to see whether if there were cost savings made by ISPs through using IXPs, the savings made were passed on to the end users.

The conclusions to be drawn from the three country case studies are as follows:

- Even where the proportion of local traffic going via the IXP was high, as in the case of South Africa with 60% in 2008, operators claimed that savings made in bandwidth costs were insignificant. However, in this case, the cost savings did benefit Tier 2 ISPs who only had to pay to

[1] Angola, Botswana, DRC, Egypt, Ghana (2 in Accra), Kenya, Mauritius, Mozambique, Namibia, Nigeria (Lagos and Ibadan), Rwanda, South Africa, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe.
[2] These arguments are summarised in Chapter 1, Via Africa – Creating local and regional IXPs to save bandwidth and Money, ITU, 2005

connect to one point (the IXP) rather than to several other providers. Where the Internet sector has been divided, as in Ghana, it has not been possible to gain the full cost advantages of a unified, single IXP.

- The original cost saving arguments for IXPs were predicated on there being a substantial difference between local, national and international wholesale charges. Since IXPs have been introduced, reductions in SAT3 bandwidth prices mean that in some cases national bandwidth costs may be the same or more than international bandwidth costs on a distance basis: for example, in Nigeria, it is cheaper to send traffic from Lagos to Sessimbra in Portugal than it is to send the equivalent amount of traffic from Lagos to Abuja. With the arrival of even cheaper fibre capacity in 2009 and 2010, this closing of prices will be a challenge for IXPs wanting to attract local traffic. But just as international prices have come down, so local and national prices will have to come into line with them. For IXPs to remain cost-effective, ISPs will need to press for lower national bandwidth charges.

- Since the retail cost of Internet subscription charges (and cyber-café access costs) in Ghana and Kenya has fallen since the introduction of IXPs, it could be argued that whatever cost reductions IXPs made for ISPs, they were passed on to subscribers or users. But since these reductions were also made by ISPs that were not IXP members as well, it is unlikely that they were as a result of savings from IXPs. In South Africa, dial-up charges have changed little over the past ten years and DSL charges have fallen since their introduction in 2003, well after the introduction of JINX. Again this makes it unlikely that any cost savings were connected with the existence of an IXP. Ghanaian and South African providers argue that cost savings were passed on to end users in the form of improved quality of service. But it is clear that cost savings from the IXP process were not passed on to end users except as part of the wider process of competition between operators.

- Whilst IXPs may have resulted in cost savings for the end user, the most significant factors have been: the ending of the international traffic monopoly (in Kenya), increased levels of competition and dramatic reductions in international bandwidth costs. For example in South Africa, international bandwidth as a percentage of total costs fell from 60% in 2003 to 45% in 2008. However, there is a direct link between IXP participants, their ISP associations and the bringing about of the factors listed above. For example in Ghana, GISPA has been instrumental in getting a special, low-cost deal on SAT3 bandwidth and in Kenya, TESPOK was at the forefront of the liberalisation process.

- Access speeds appear to have improved but it is difficult to separate the impact of improved national and international links from the speed advantage delivered by the IXP. Furthermore, as international bandwidth has come down in price, end users have had access to faster download speeds.

- Whilst the volume of traffic going through IXPs in Kenya and South Africa has increased dramatically, even these increased volumes have to a large extent been overshadowed by increases in international bandwidth. Indeed local traffic has fallen as a proportion of overall traffic in South Africa. There is no traffic measurement at the Ghana IXPs so it is not possible to say what has happened either in terms of the proportion of local traffic or the overall growth of traffic at the IXPs.

- Likewise the growth in local content and its use by end users has been eclipsed by a much wider interest in international content. As international fibre has become cheaper, it has been easier for operators to supply Internet users more cheaply. As a result, the number of people using the Internet has gone up. Although local content has grown in all three countries, the majority of use (particularly web mail access) remains international. For example, Facebook and You Tube are amongst the top ten sites accessed in African countries analysed by Alexa.com. However, this growth in Internet use has also benefited a small number of local sites. IXPs have supported the introduction of new local services and applications: for example in Kenya, the implementation of online tax reporting by the Kenya Revenue Authority and the availability of freeware hosted by the University of Nairobi.

1. Case study one: Ghana

1.1 Background to setting up of Ghana's IXPs

Ghana launched its much-anticipated IXP, the Ghana Internet Exchange (GIX) on18 October 2005 at the Ghana India Kofi Annan Centre of Excellence. The GIX is run and operated by the Ghana Internet eXchange Association (GIXA)[3], an independent non-profit corporation established by the Ghana Internet Service Providers Association (GISPA)[4] and other stakeholders interested in joining and growing the GIX.

However, due to different views amongst the ISP stakeholders about where best to interconnect, another IXP was set up by Ghana Telecom, the incumbent telecom operator in June 2005 and it is called the Accra Internet eXchange (AIX).

GISPA was the lead organisation that facilitated the establishment of the GIX in collaboration with other organisations including: the Ministry of Communication; Ghana's regulator, the National Communications Authority; the Ghana India Kofi Annan Centre of Excellence, Geekcorps, Packet Clearing House, African Internet Service Providers Association (AfriSPA), Ghana Network Information Centre; the French Government NTIC through the French Embassy in Ghana and GISPA members who donated resources, time and money in various forms.

The GIX has its primary objective providing efficient interconnectivity within Ghana for Internet traffic, allowing local Internet Service Providers and Network Operators to easily exchange traffic within Ghana, while improving connectivity and services for their customers. The facility uses the router-reflector model of establishing the interconnect medium for the exchange of traffic. This provides an opportunity for operators to peer (exchange traffic) at a national level.

The original seven members connected to the GIX at the inauguration in October 2005 were BusyInternet, Ecoband, GS Telecom (subsequently taken over by Gateway Communications), Internet Ghana, IDN, K-Net and Teledata ICT. Membership has subsequently reduced to four members: BusyInternet, Ecoband, Gateway Communications and K-Net.

The following is the technical diagram of the Ghana Internet Exchange.

[3] www.gixa.org.gh
[4] www.gispa.org.gh

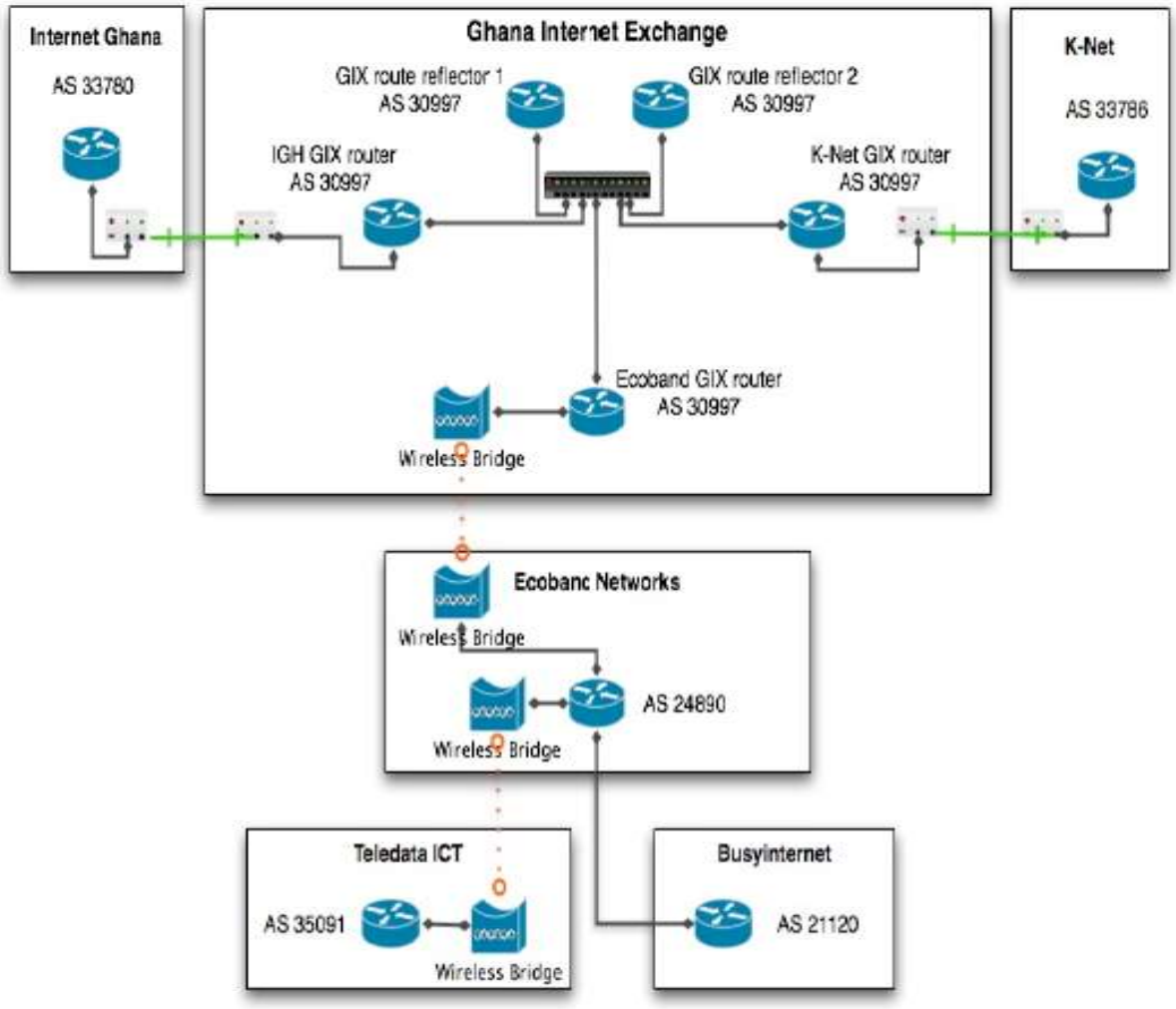


Diagram 1: Ghana: How GIX members are connected

Teledata ICT and BusyInternet were originally connected to the GIX through Ecoband but the latter is no longer providing transit to Teledata ICT. However, Teledata ICT have said that it will connect itself soon. It is not clear why Internet Ghana disconnected from the GIX.

The AIX was set up in June, 2005 as an alternative to the GIX. It is located on the first floor of Ghana Telecoms Tertiary Building at its Head Office in Accra-North. Currently Network Computer Systems Ltd. (NCS), Ghana Telecom's ISP (GT-Net), NAS Global, Internet Ghana, Teledata ICT and AfricaOnline are the six ISPs connected to the AIX and with the exception of NAS Global all the others are exchanging traffic. The AIX started with three members (NCS, GT-Net and AfricaOnline) when it first opened.

Some ISPs felt that since they already had the points of presence at Ghana Telecom's Accra-North facility it made sense for them to interconnect there. Another reason was that the some of those involved saw GIX as a challenge to them and that they therefore needed to build their own exchange.

Talks have been held between Ghana Telecom and GISPA to connect the two IXPs but this has not happened. According to Eric Osiakwan, the Executive Secretary of GISPA, one of the major stumbling blocks is Ghana Telecom's lack of commitment to connecting the two Internet exchanges. He said that the GIX has been ready to connect to the AIX but the AIX team has always had a reason to postpone it.

According to Alex Sulzberger, CEO, Ecoband, the biggest stumbling block to achieving a unified Ghanaian IXP is the interconnection between the AIX co-location facility at GT Accra North and the GIX. Despite several promises from Ghana Telecom to interconnect with a 2 link Mbps, this has not yet happened.

The last time the two groups met, the AIX team said that Ghana Telecom management had not yet given approval for this to happen. Ghana Telecom is the largest market player in terms of broadband subscriptions and this makes its presence particularly important for those wishing to interconnect at a national level.

1.2 Impact of IXP on Pricing of Internet

The majority of those spoken to for this study felt that IXPs have had a negligible effect on both retail and wholesale pricing. Most of the factors that have created a downward trend in wholesale and retail prices have been external like the drop in international fibre prices.

At the retail level, the largest proportion of Internet users in Ghana access the web and their e-mail at cyber-cafés. There are around 1,200 cyber-cafes in the whole of Ghana, of which about 700 are found in the capital Accra. The average cost of Internet access at these cyber cafe average a little below $1 per hour.

Cyber café pricing in Ghana has in most cases reduced by two-thirds since 2001. However, the costs of operating a large cyber-café in the capital Accra mean that other costs have a greater impact on pricing over time, For example, below is BusyInternet's cyber café pricing per hour over the last five years:

Table 1: Ghana: BusyInternet: Cyber Café cost per hour (2004-2008)

Year	2004	2005	2006	2007	2008
Prices ($)	1.0	1.2	1.2	1.2	1.5

Ghana Telecom is the provider to over 90 per cent of all cyber-cafes and yet it remains unconnected to GIX and only connected to a smaller number of ISPs (3) at AIX. Therefore, the impact of local exchange is bound to be limited by this factor and has probably been negligible over the last five years.

Retail ISP prices have fallen over the years but this is attributed to reductions in wholesale prices rather than through the impact of IXPs.

According to David Saade, Technical Director of BusyInternet there are a some users who have benefited, but few costs have been passed on since the overall saving has not been that large. The ISP saves some bandwidth and access is faster for the customer. However, he was quick to make the point that exchange members only see the full benefits of an IXP when most of the players in the market are peering at a single exchange.

There has been a considerable reduction in retail subscriber prices since 2003. Below is a table of average GISPA charges for bandwidth from that date:

Table 2: Ghana: Average Retail Charges by GISPA members (2003-2008)

	Year	2003	2004	2005	2006	2007	2008
Standard Packages 75%shared with25% dedicated	Bandwidth						
	64kbps	$450	$350	$299	$175	$78.39	$121.95
	128kbps	$800	$700	$499	$299	$161.15	$200.34
	256kbps	$1400	$1400	$799	$400	$322.22	$383.26
	512kbps	$2500	$2500	$1399	$600	$479.08	$740.40
Premium Packages 100% dedicated							
	64kbps	$915	$800	$499	$426	$304.87	$304.87
	128kbps	$1830	$1595	$799	$653	$522.63	$522.63
	256kbps	$3660	$3190	$1299	$1106	$888.48	$862.35
	512kbps	$4400	$4400	$2299	$2012	$1611.46	$1611.46

Wholesale prices have reduced only as a result of competition and reduction in the prices of international fibre on SAT3 supplied by Ghana Telecom. SAT3 costs a GISPA registered ISP $4,010 per E1. At inception, SAT3 prices were set at $12,000 for a similar amount of bandwidth. Its satellite equivalent costs $5,050 also down from $15,000 in 2002. The setting up of the two IXPs in 2005 has not had any effect on wholesale pricing in Ghana. Because although a small proportion of interconnect traffic flows locally, there has been a large increase in the amount of international traffic over the same period:

Table 3: Ghana: Wholesale rates (2002 – 2008)

	2002	2003	2004	2005	2006	2007	2008
SAT3 (1 MB duplex)	$6,000	$6,000	$5,250	$4,000	$3,000	$2,005	$2,005
Satellite (1MB duplex)	$15,000	$14,500	$12,000	$10,000	$7080	$5,050	$5,050

Overall dial-up costs are four times cheaper than they were in 2001 and International wholesale rates have also gone down considerably. The following table summarizes the rates for retail and wholesale Internet services:

Table 4: Ghana: Summary comparison of retail and wholesale prices (2001 vs 2008)

		2008	**2001**
I	Internet Access Cost	Dial-up $25-$35 per month/ $200-$250 per year Broadband: Average Installation fee: $120 plus Subscription fee of $40 per month	X 4 More expensive
II	Average Cost of 20 hours of Internet Use (cyber café)	$20	$60
III	Price of full circuit (to US/UK) SAT3	Non-GISPA - $4,000 Non-ISP -$6,000 GISPA members - $2,005	$6 000
IV	Average Satellite Price (1 Mbit) – duplex	$5,050	$15,000

1.3 Other impacts (speed of access, traffic volumes and local content)

Data on access speeds to local Internet content in general is not available in Ghana on a time series basis. ISPs tended to record traffic levels over their networks rather than access speeds. However, one ISP[5] told us that the access speed for local content and e-mails in 2008 was about 40 milliseconds.

Overall traffic at the GIX is relatively modest as it does not include the major broadband player, Ghana Telecom and only has one retail ISP member (BusyInternet), with the rest of its members focused on corporate subscribers. There are currently no systems in place to monitor traffic volumes although there are plans to put these in place. There are also no monitoring systems at

[5] BusyInternet

AIX but its administrator estimates that its largest user Ghana Telecom (now owned by Vodafone) puts 256 kbps of traffic through it.

Those interviewed said that although local content was growing, it was not yet growing very quickly. However, there is an increased level of local hosting of applications. Despite the perception that Internet content has not grown very rapidly, the number of domains has risen steadily:

Table 5: Ghana – Number of domains (2004-2007)

2004	407
2006	380
2007	2,899

1.4 The impact of other factors on changes in pricing

Several factors such as international connectivity, improvement in local connectivity and competition have all affected Internet pricing and it is very difficult to separate out the rather modest impact GIX and AIX might have had on pricing.

The availability of the SAT3 fibre optic cable has revolutionised the Internet sector in Ghana. Despite the relatively high prices, Internet use has increased due to considerable reductions in wholesale and retail prices. It was recently estimated that the country's utilizations of the SAT-3 is about 15-20% (6 STM1s) of the cable's capacity into the country. One source in Ghana Telecom told us that the company projects that it will be using 15 STM1s by 2011.

SAT3 prices were again lowered in 2008 for GISPA members following discussions between GISPA, Ghana Telecom and the Ministry and a considerable number of people have access to the Internet and telecommunications.

Almost all ISPs in Ghana buy access to the cables' capacity, some combining its use with VSAT. Since the SAT-3 cable is the only undersea cable system that Ghana has access to, it raises concern on the lack of redundancy; particularly with respect to international cable connectivity (satellite communication is used as an alternate mode of connectivity). Four new cables[6] will arrive between 2010 and 2011, providing new levels of competition for international fibre and prices are likely to reduce still further over the next 3-5 years.

Improvements in local connectivity have also played a part in the reduction of prices and improvements in local access speeds. Most of the country's fibre assets were put together as part of the Ghana Telecom sale to Vodafone. These included Voltacom, the fibre arm of the Volta Rivers Authority, whose

[6] Glo One, Main One, WACS and ACE.

network connected the following places: Accra, Kumasi, Nkawkaw, Winneba, and Cape Coast and to Obuasi. Ghana Telecom's own fibre network also covers the populous south of the country: Accra, Cape Coast, Takoradi and Kumasi. Its coverage of the north of the country (including Tamale) is achieved through a microwave network. As part of the sale, Vodafone made a commitment to extend the use of fibre across the country.

Regulation has not changed much since the initial liberalization of the industry. But it has been liberalisation that has brought about competition and hence a reduction in prices for all telecoms products in Ghana. The National Communications Authority (NCA) is the independent regulator. It was created as a single regulatory agency in 1996 to implement the Telecommunications Act. Its objectives include: ensuring effective competition and efficient investment in communications, regulating the telecommunications sector and promote a good operating environment for all participants.

There is no doubt that increased competition has led to the fall in both retail and wholesale prices. As the number of ISPs grew, there was increased competition and hence providers tended to reduce prices to compete effectively against other players. One ISP visited during this study said it would reduce its prices immediately when it learned of the lower prices of another ISP. In addition, the prices shown in ISPs' brochures and web sites are often not the actual prices offered to customers and these are often lower than the advertised price.

However, with the introduction of broadband, Ghana Telecom has successfully lowered its prices to a point that has made it the largest broadband provider in the country. What is not clear is the degree to which Ghana Telecom enjoys advantageous SAT3 wholesale prices to which its competitors do not have access: the retail and wholesale parts of the company are not separated in a way which allows this to happen transparently.

Another key pressure on prices has been the existence of the local ISP association. Through intense lobbying at various levels of government, the National Communications Authority and Ghana Telecom, The Ghana Internet Service Providers Association has been able to persuade Ghana Telecom to reduce SAT3 prices in Ghana. These reductions in turn gave competition to VSAT providers and they responded by reducing their prices.

1.5 Challenges to the development of IXPs

A number of challenges to the development of IXPs exist within the industry in Ghana. When Ghana's ISPs Association decided to form a non-profit organization to set up the Ghana Internet Exchange (GIX), its objectives were to ensure that all member ISPs joined the GIX but that has not happened. Three years into the set up of the IXP, only four operators are truly peering at the infrastructure. This research found that operators have not joined the GIX because they do not see the advantages of connecting to the infrastructure.

The AIX has six ISPs members connected to the physical infrastructure but only five are truly peering.

Therefore, not only is there no unified IXP In the country but as a result, the IXPs have not developed sufficiently to demonstrate the full benefits that they might be able to deliver. Furthermore, there are no mobile providers amongst the IXP memberships despite the rapid growth of mobile Internet users. So there is still a need to raise awareness of the benefits of IXPs.

Members of these two IXPs spoken to for the study are unanimous that the IXPs have not developed to the stage where the full benefits of setting up IXPs have been achieved, and that there is still the need to raise awareness on the importance joining the IXPs.

But even with greater levels of awareness, the fundamental divide between the two IXPs runs deep. The GIX believes that it is ideally sited in an independent premises (AITI-KACE) but AIX thinks that Ghana Telecom's Accra North facility is ideal as it is part of the largest player in the broadband market. Although AIX is formally committed to connecting to the GIX, it is clear that underlying issues have prevented this commitment from speedily being implemented. Until these kinds of differences are settled and a unified IXP is created, no ISP will feel the full benefits of an IXP.

There is a general lack of trust between ISPs. IXPs, particularly not-for-profit association models, rely on their participants to cooperate and co-ordinate to be effective. Building trust and emphasizing neutrality and mutual benefits were underscored as essential in order to bringing parties together to establish an exchange point. Lack of trust between ISPs has discouraged co-operation and hindered the development of ISP associations and IXPs in Africa generally and in Ghana in particular.

Another issue is the cost of technical expertise. The success of an IXP has been said to hinge on its ability to route traffic locally in an efficient, cost effective manner. This requires competent engineers to implement and support day-to-day operations at both the participating ISPs and the IXP switching facility. Mike Jensen, an independent ICT consultant in Africa has noted that the cost of this expertise may actually exceed the cost of paying for international transit, persuading many ISPs to settle for switching their local traffic through international links. Therefore, there is a need to develop a critical mass of local technical skills and expertise, particularly among smaller ISPs.

The research has put a spotlight on the fact that the IXPs are poorly managed in terms of data monitoring. There are no statistics for traffic passing through the IXPs. There is no traffic monitoring software installed. So there is no way of knowing the volume of traffic going locally or of the speed at which it travels around the network. Therefore it is impossible to calculate what percentage of overall traffic in Ghana passes through both exchanges.

2. Case study two: Kenya

2.1 Background to setting up of KIXP

KIXP has evolved from a concept mooted by the then emerging and vibrant Internet services providers' (ISPs) community in late 1990s. Pioneering ISPs were concerned that there were a number of things that were impeding Internet growth and most importantly, standing in the way of providing a satisfying experience of internet use for the Kenyan internet consumer. The key challenges and claims for the IXP are outlined below:

- All the ISP traffic was switched by upstream ISPs abroad even if the traffic was local. The ISP community led by Telecommunications Service Providers of Kenya (TESPOK) estimated that the 30% of all international traffic[7] was local and therefore need not be switched internationally. Switching local traffic internationally was a waste of scarce resources.

- By keeping local traffic local, the ISPs and indeed the nation would save on nternational bandwidth costs which were much more expensive than the local switching costs.

- By exchanging local traffic locally, latency would reduce considerably for accessing local content sites. Latency in accessing international content was high, often up to 1200 milliseconds (this compares with 40 milliseconds in the previous case study in 2008).

- Additionally, accessing local hosted sites would decrease access speeds and give the Kenyan internet consumer a new web surfing experience which was not available if accessing internationally hosted sites.

- As a local IXP would offer more stable infrastructure, more applications could be implemented. A simple case in point is voice as well as software applications

That was the dream of TESPOK and its pioneers in early 2000. Under the leadership of Richard Bell and Brian Longwe, and with the support and co-operation of development partners, the communications regulator (much later) and finally the telecom operators, this dream was realised and today Kenya has a vibrant IXP exchanging local traffic.

The membership growth was phenomenal. In the first year of full operation, seven ISP joined KIXP. This unleashed a process with all the other operators joining as illustrated in Table 6 below so that by 2006 there were 20 members.

Table 7: Kenya: Growth of membership at KIXP (2002-2006)

[7] See Bell, R, The Halfway Proposition, summary at www.afrispa.org

	Members at KIXP		*Year joined*
1.	Africa Online Ltd/UUNET		2002
2.	Kenyaweb. Com		2002
3.	Interconnect Limited		2002
4.	Nairobi Net Ltd		2002
5.	Swift Global Ltd.		2002
6.	Communication Solutions/Access Kenya		2002
7.	Wananchi Online/ ISPKenya		2002
8.	MitsumiNet (K) Ltd.		2003
9.	Skyweb Technologies Ltd		2003
10.	SimbaNet.Com Ltd		2004
11.	Kenya Data Networks		2004
12.	Sahannet Ltd.		2004
13.	Kenya Revenue Authority		2005
14.	Jambonet K Ltd.		2005
15.	Jamii Telcom		2005
16.	Sasanet K Ltd.		2006
17.	Safaricom Ltd		2006
18.	KENET		2006
19.	Karibunet		2006
20.	KENIC		2006
		NTP Server	2006
		1 root server	
		F root server	

Source: KIXP

In 2008, the KIXP had grown in membership as well as exchanging up to 36mpbs of traffic. Its current membership is 26 comprising of the following member groups;

- 16 ISP networks;
- 3 Internet Backbone/Gateway providers including the incumbent Telkom Kenya Ltd;
- 1 E-Government provider- Kenya Revenue Authority (KRA) for its online customs clearing system;
- National Research & Education Network (NREN) – Kenya Educational Network (KENET);
- Kenyan ccTLD Registry – Kenya Network Information Centre (KENIC)
- 1 local loop voice and data operator (LLO);
- 1 Commercial Bank;
- and 2 Mobile operators - for 3G/EDGE/GPRS data services

Additionally, the following actors provide value-add services through KIXP:

- F & J Root Servers mirror instances
- .Com and .NET gTLD Root Server mirror instances
- .KE & 25 other ccTLDs – PCH Anycast network
- Public GPS based Network Time (NTP) Server
- Public looking glass - Route-views

KIXP's membership and its value added features have transformed it from being a simple point of traffic exchange launched in 2002 to be a critical infrastructure for internet in Kenya.

2.2 Impact of IXP on pricing of the Internet

According to data from the Kenya regulator CCK, retail subscriber tariffs have fallen between 2005 and 2007. As shown in table 2 the cost of a 64 kpbs subscription has reduced by 28%. However, one of the main factors responsible for this price drop has been competition that was introduced by the regulator in 1999. By contrast with Ghana in the first case study, Kenya is entirely reliant on relatively expensive satellite bandwidth until the arrival of a number of three international fibre cables in 2009 and 2010.

Table 8: Kenya: Comparative international wholesale bandwidth charges (2005-2007) (ksh) (US$ =Ksh 77)

		2005	2006	2007	% drop
Bandwidth (kbps)	32	17,000	14,740	12,480	27
	64	34,850	29,905	24,960	28
	128	62,900	56,410	49,920	21
	256	119,000	109,420	99,840	16
	512	231,200	215,440	199,680	14
	1024	455,600	422,800	390,000	14

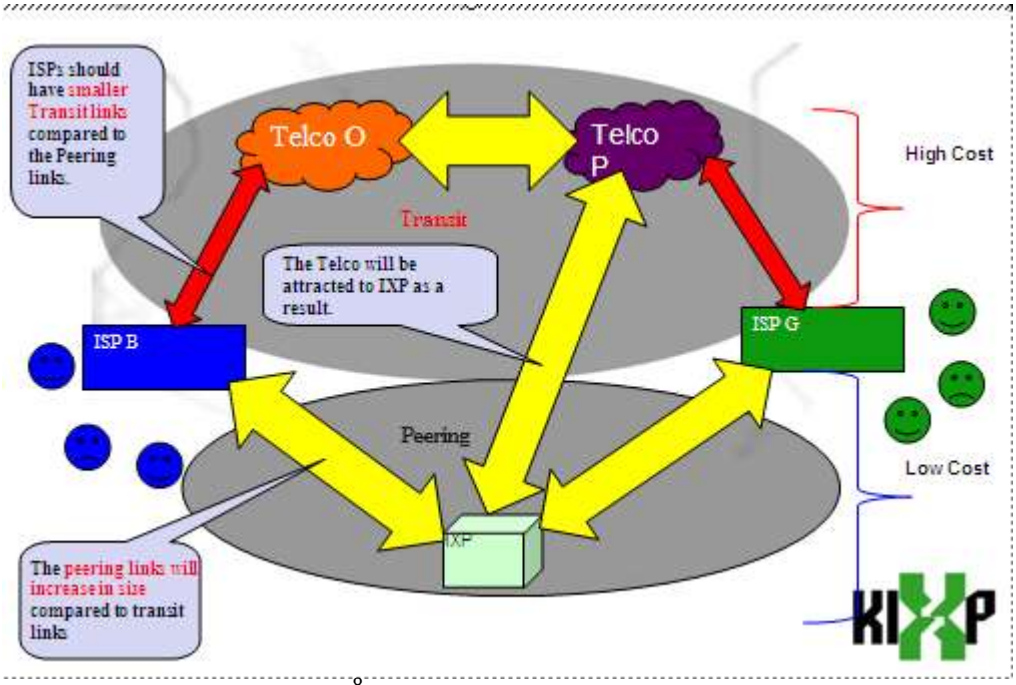
Source: CCK database

Thus, while international bandwidth charges have stabilised at around USD 5,000 per mbps over the last five years, retail subscriber charges (see below) have continued to fall. The challenge for the ISPs is to reduce their reliance of international bandwidth by peering at the KIXP. This is now happening and is best illustrated by the case of a local ISP that committed to KIXP at an early stage.

This ISP had a 144 mbps uplink since 2002 and it has remained at this level to the present day. However, its link to KIXP has gone from 256 kbps in 2002 to 1 GB in December 2008. However, for many other key players, their level of international bandwidth has continued to increase alongside increases in their link to KIXP.

The model below in figure illustrates the evolution of the local ISPs as they progressively increase the capacity of the local links to KIXP, whilst maintaining the capacity of the international link to almost the same level thus reducing the expenditure on bandwidth. This model works if international bandwidth prices remain constant but the introduction of new fibre cables to Kenya will see further dramatic falls in wholesale prices over the next three years. As a result, both international and KIXP bandwidth will grow over the same period.

Diagram 2: Kenya: Model of bandwidth deployment of ISPs



Source: Mwangi, M (2008)[8]

The end user cost has changed radically over the decade – the tariffs for Internet service in August 1998 were prohibitive for individuals: for example, a 32kbps leased line cost US$1,500 per month while individual accounts range from US$5.00 to US$8.00 per hour (off peak/peak) to US$125.00 per month for "unlimited use."[9] . By early 1999 the tariffs came down to US$1.68 per hour of Internet use as illustrated in Table 9 below:

Table 9: Kenya: Total internet access charges (1999)

Local telephones charges			Exchange Rate	Unlimited internet account charges		
Per minute Ksh1.17	Per hour			Monthly	hourly	Total /hour
	Local	US$		US$		
	Ksh70.20	1.13	Ksh62	97	0.55	1.68

VAT not included,. All the Internet accounts are unlimited usage assuming 8-hr usage in 22 days for purpose of comparison.

Source: Mureithi M (1999)[10]

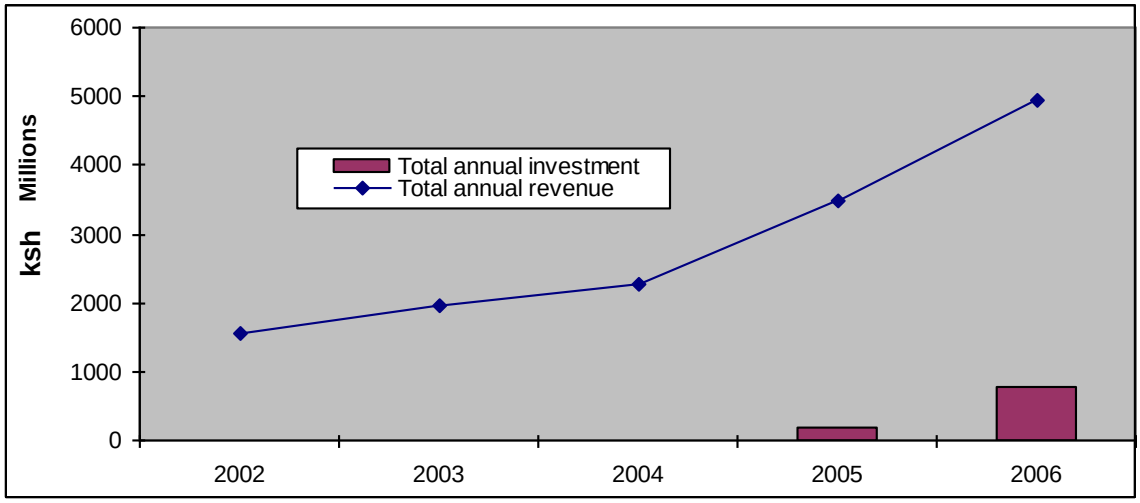
At the same time the cost of the internet access using cyber café ranged between Ksh 10-15 per minute .These tariffs have come down significantly and in 2008 the tariff for Internet use is much lower. Currently prices for cyber cafes are Ksh 1 per minute and a dial-up Internet subscription with Africa Online is Ksh11,999 for unlimited use. The latter is a higher price than was available ten years ago. Mobile Internet prices are calculated by capacity and and therefore not directly comparable: prices per MB vary from Ksh2.50-8.00. Therefore most Internet access costs are considerably cheaper than they were 10 years ago.

[8] See Mwangi M (2008)The Impact of IXPs: An African Perspective IXP presented at Best Practice Session , IGF, Hyderabad,
[9] CIDCM STAFF REPORT University of Maryland published in Aug 1998 -
[10] See Mureithi M (1999) Technical feasibility study for ALPID - IDRC

No data is available to ascertain the cost of the local portion of the ISP operation, however the greatest component of the local operation is bandwidth as supplied by the Internet Backbone Gateway Operators (IBGOs) or earlier by the Telkom Kenya. Pre-2004, the cost of the local bandwidth was dictated under monopoly conditions but after 2005, multiple players were licensed. Competition resulted in the lower prices of the bandwidth as illustrated in Table 6.

The regulator CCK tracks the revenues and investment from the data sector. This data however is global and it is not broken down into its various elements. As illustrated in figure 2 the growth in revenues is faster after liberalisations in 2004 suggesting that competition ushered in new products and new revenues streams. Similarly, the level of investment increased in the two years since CCK started tracking the data.

Chart 1: Kenya: Data operators – revenue and investment (2002-2006)



Source: CCK database

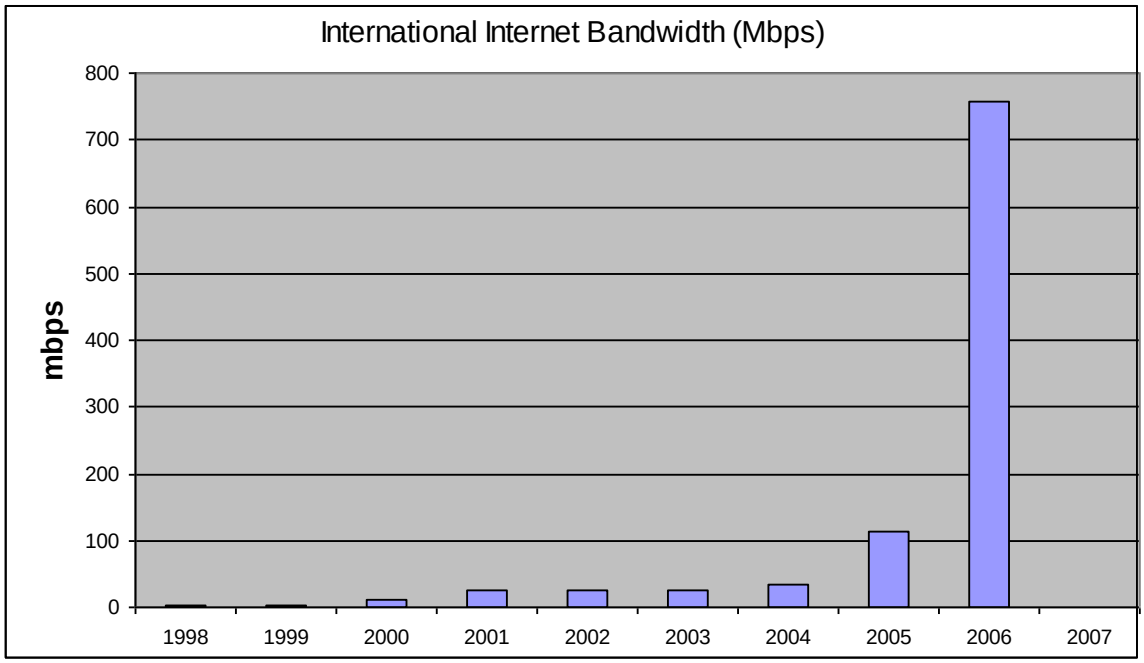
While the specific role of KIXP is not delineated by the data , it is conceivable that it was a key infrastructure that contributes to the capacity for the operators to invest in the sector thereby contributing to the stability of national internet infrastructure.

1.3 Other impacts (speed of access, traffic volumes and local content)

Response time on a test conducted on a national newspaper, The Nation (which is hosted outside the country) show latency is high at 741 milliseconds with 16 hops. However, in July 2009 the first of three international fibre cables (Seacom) started operations and it will be followed by two more (TEAMS and EASSy).

Data available indicates that international bandwidth has grown significantly over the last ten years. According to ITU data, bandwidth grew from just 2 mpbs to over 700 mbps in 2006 as illustrated in Figure 1 below. The greatest jump in growth is from 2005 after the liberalisation of the international gateway by the Government.

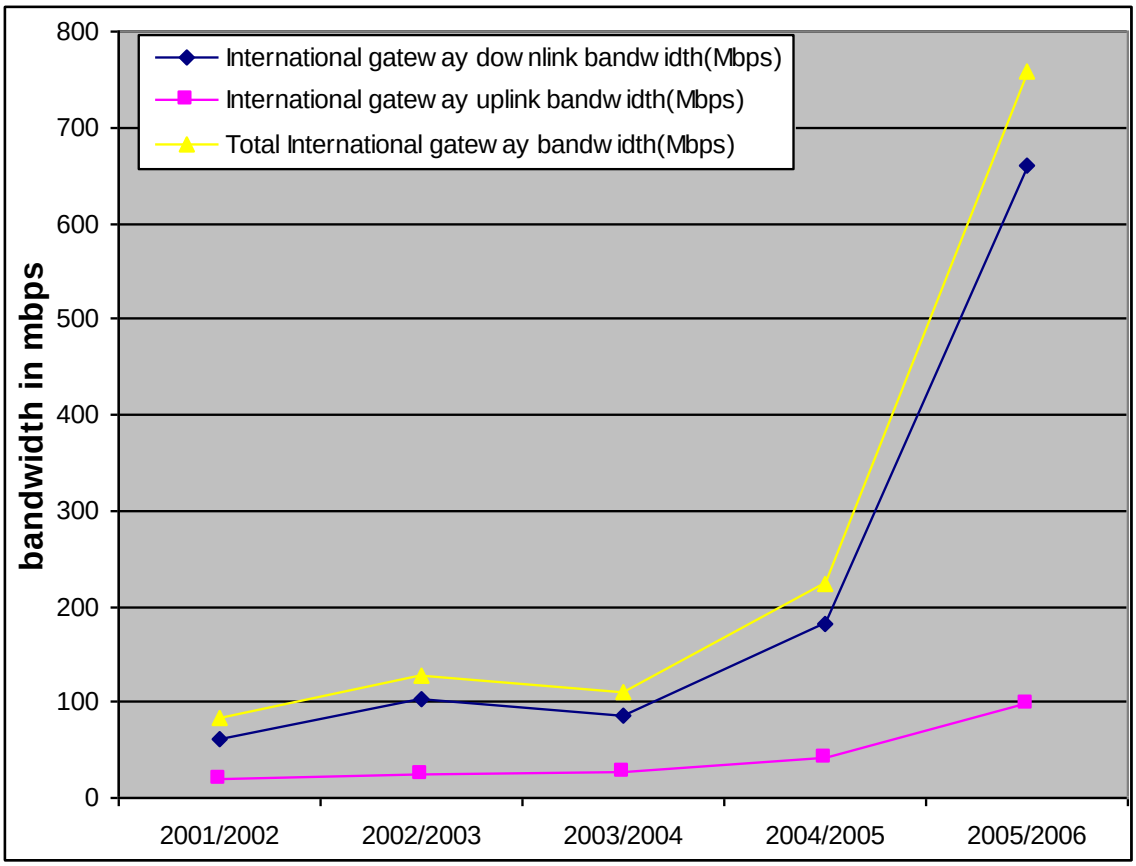
Chart 2: Kenya: Growth of international Internet bandwidth (2002-2006)



Source: ITU Indicators

A closer look at the traffic direction indicates that the fast growth has been in downlink traffic as illustrated in Figure 2 below based on data by Communications Commission of Kenya (CCK) Internet Market Study carried out in 2006:

Chart 3: Kenya: Uplink and downlink international traffic (2001/2002 – 2005/2006)

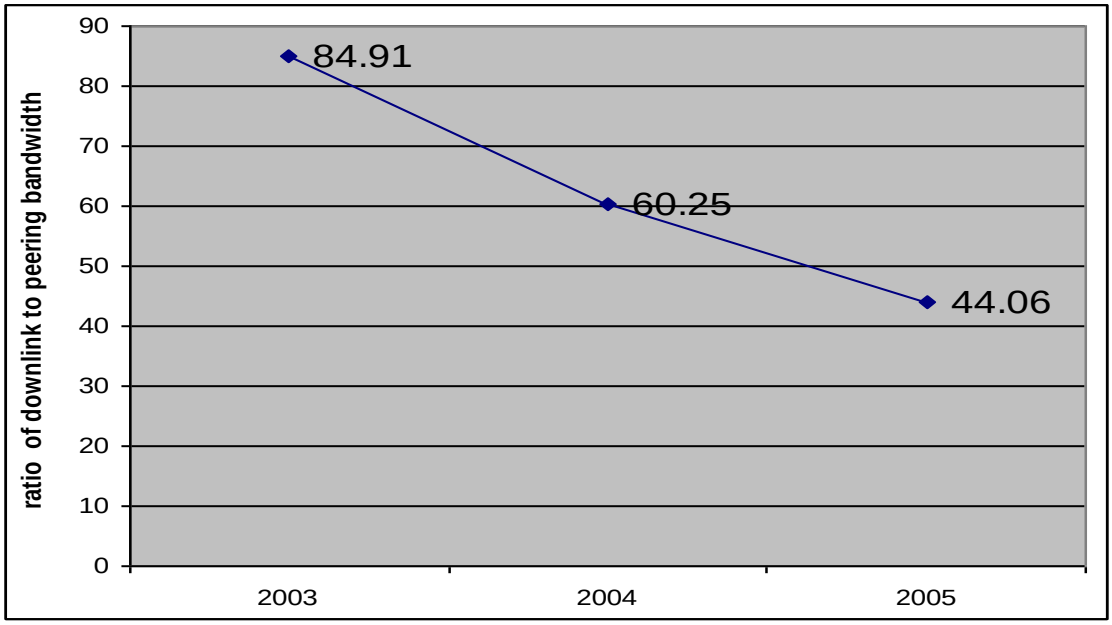


Source: CCK internet market study

The downlink to uplink ratio increased rapidly to a factor of seven times immediately after liberalisation of the international gateway in 2004/2005. In 2001/2002, the corresponding ratio was three times. There was drop of up to 20mbps in 2003/2004 and the most plausible reason for this is mergers in the ISP sector, not the the introduction of KIXP the year before. Nevertheless, the growth of international bandwidth is high and the impact of the KIXP is not noticeable. This is probably due to the high demand for international content.

For KIXP to have had an impact, it is likely that the ratio of downlink bandwidth would decline relative to the amount of traffic going through KIXP. According to the CCK internet market survey, the ratio of the downlink bandwidth to the IXP peering bandwidth is still very high at about 1:44 up to 2005 as illustrated in Figure 3 below. Data for 2006 and 2007 was not available but it is expected that the ratio has fallen at the same rate but is still significant. However, it should be noted that the ratio has declined over the part of the period of KIXP's existence where data is available.

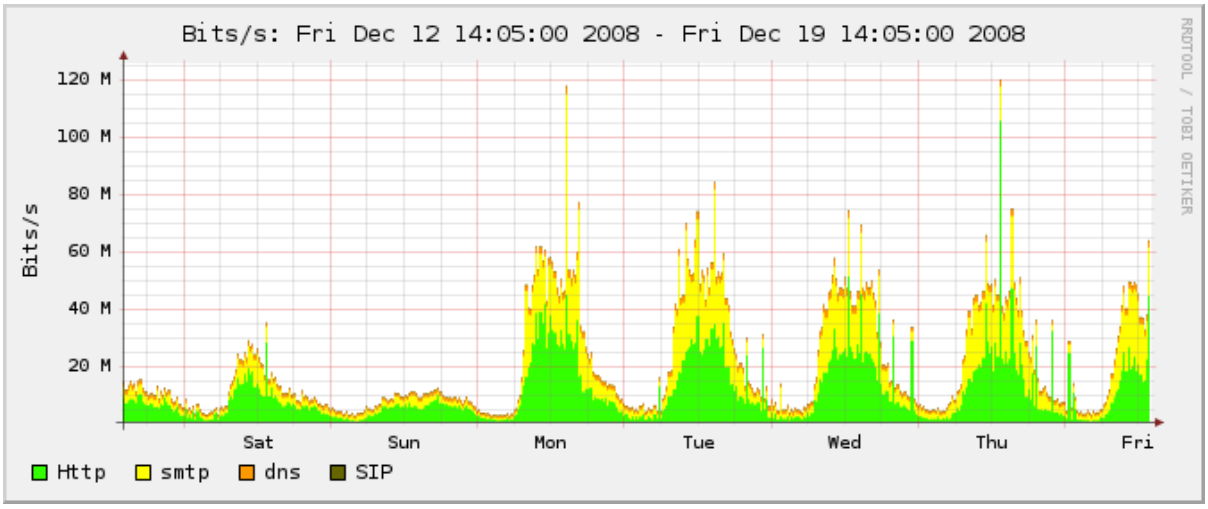
Chart 4: Kenya: Ratio of peering bandwidth to downlink bandwidth (2003-2005)



Source: CCK internet market survey

This high ratio pattern is an illustration of the high dependence on content from abroad. Thus, KIXP is a key infrastructure to keep local traffic local but other initiatives are necessary to stimulate growth of local traffic. The most important component to stimulate local traffic is content and voice applications among others. A review of the traffic exchanged at the KIXP is email and web surfing as illustrated in chart 5:

Chart 5: Kenya: Traffic components exchanged at KIXP (2008)



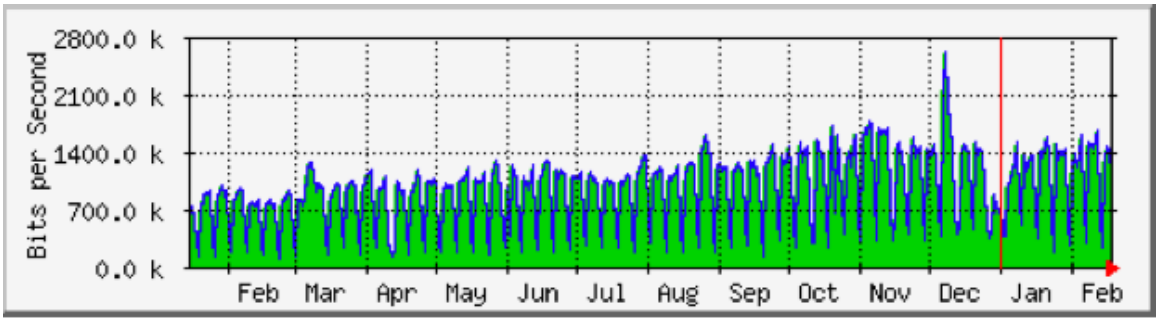
Source: KIXP

A growth of local content through increased local hosting would significantly add to the exchange of local traffic. Other applications and especially local voice traffic would significantly increase local traffic. At present, voice traffic is still negligible. The KIXP is configured for up to 1Gbps traffic and therefore there is a enormous opportunity to exploit the infrastructure to reduce cost of Internet experience for the Kenyan consumer, once there is an increase in local content.

Data indicates that the growth of international internet bandwidth is high as illustrated in Figures 3 and 4 and therefore none of the ISPs would have reduced the volume of bandwidth to reduce the expenditure on bandwidth. Consequently, ISPs have not scaled down on expenditure for international bandwidth, however, if KIXP did not exist, then the demand for the international bandwidth would be much higher to cater for the traffic exchanged at the KIXP. The benefit to the ISPs is therefore in the savings they have realised from international bandwidth.

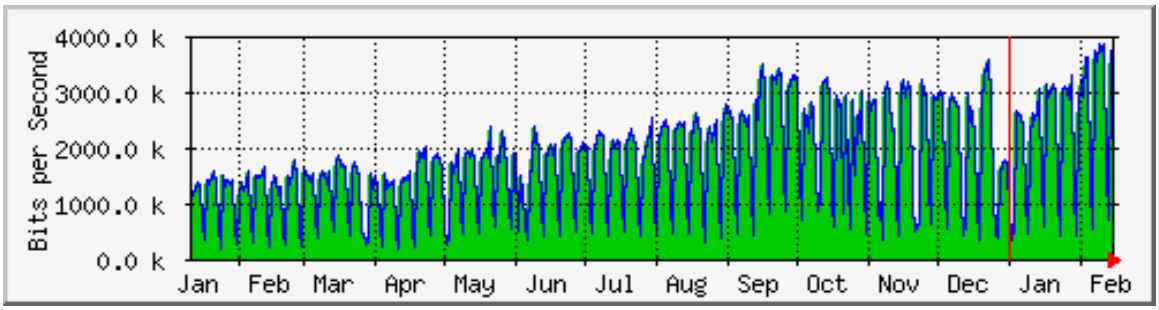
This peering traffic has been phenomenal as illustrated in Charts 6-9 rising from nothing before the implementation of KIXP to the current 36mbps. This peering bandwidth however set against the international bandwidth represents approximately 5%.

Chart 6: Kenya: KIXP bandwidth (2004/2005)



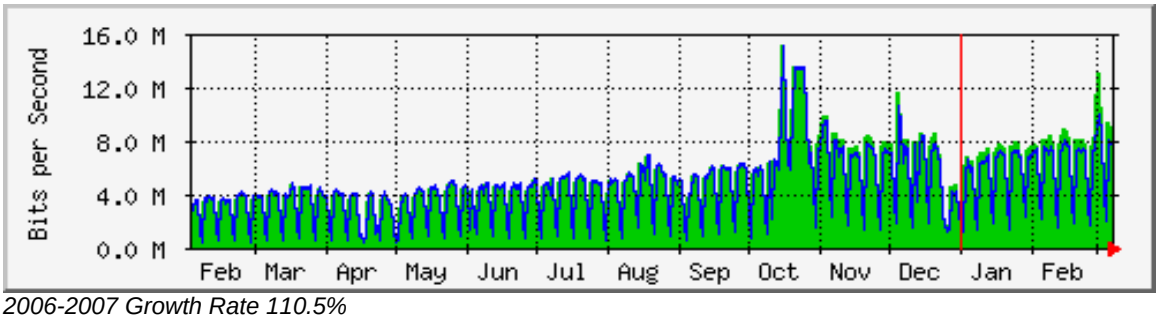
Yearly Usage Statistics: 2004-2005
Annual Growth Rate: 77% February 2004: 900 Kbit/s, February 2005: 1.6Mbit/s

Chart 7: Kenya: KIXP bandwidth (2005/2006)



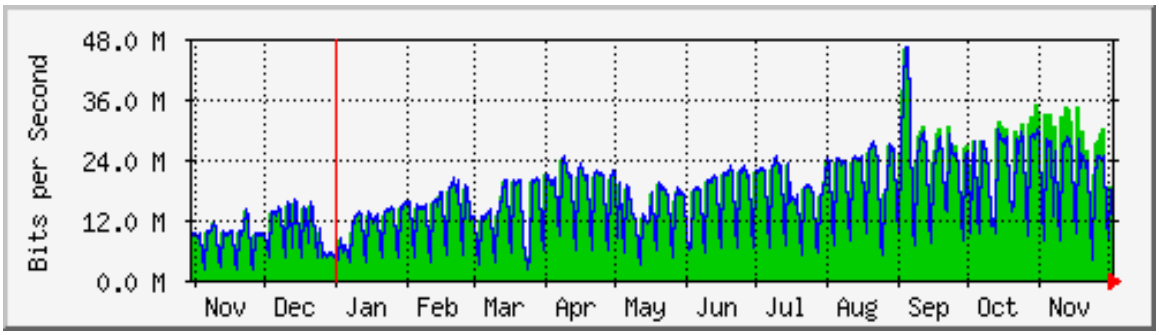
Yearly Usage Statistics: 2005-2006
Annual Growth Rate: 137%, February 2005: 1.6Mbit/s' February 2006: 3.8Mbit/s

Chart 8: Kenya: KIXP bandwidth (2006/2007)



2006-2007 Growth Rate 110.5%

Chart 9: Kenya: KIXP bandwidth (2007/2008)



2007-2008 Growth rate 200%

This is growth is phenomenal and illustrates the important role of the KIXP as a piece of national infrastructure. All this traffic would have been exchanged through upstream ISPs at great costs to the country.

At the current cost of bandwidth, the country is saving up to US$72,000 per month by switching local traffic locally. With a peering bandwidth growth of the 200% noted in the 2007/2008, this volume of saving will increase. This saving is realised by ISPs and the issue just how significant it is bottom line of the ISPs and whether some part of cost this advantage is transferred to the Internet consumer. The monthly saving by switching through KIXP represented 1.3% of the total turnover of data operators in 2006.

Access speed is a clear benefit of KIXP. Because Kenya accesses international content using satellite bandwidth, there are inevitably some latency delays. But local content is now accessed in speeds measured in mbps and is only limited by the speeds of the local servers and not the size of the international link.

Thus, there is clear benefit in access speeds for the consumer for locally based content. Unfortunately, the local content developers and the hosting organisations have not marketed this benefit. When a content provider was asked why they do not market this benefit of higher access speeds, they indicated that the economic benefits of cheaper hosting abroad is more significant and thus they encourage their clients to host abroad.

Kenya' Internet stakeholders need to address wider issues for Kenyans to benefit from these higher local access speeds in the following areas :

- create awareness that locally hosted sites can be accessed faster as long as the host is connected to the KIXP. A straw poll of a number of Internet users indicated that many are not conscious of the difference in access speeds.

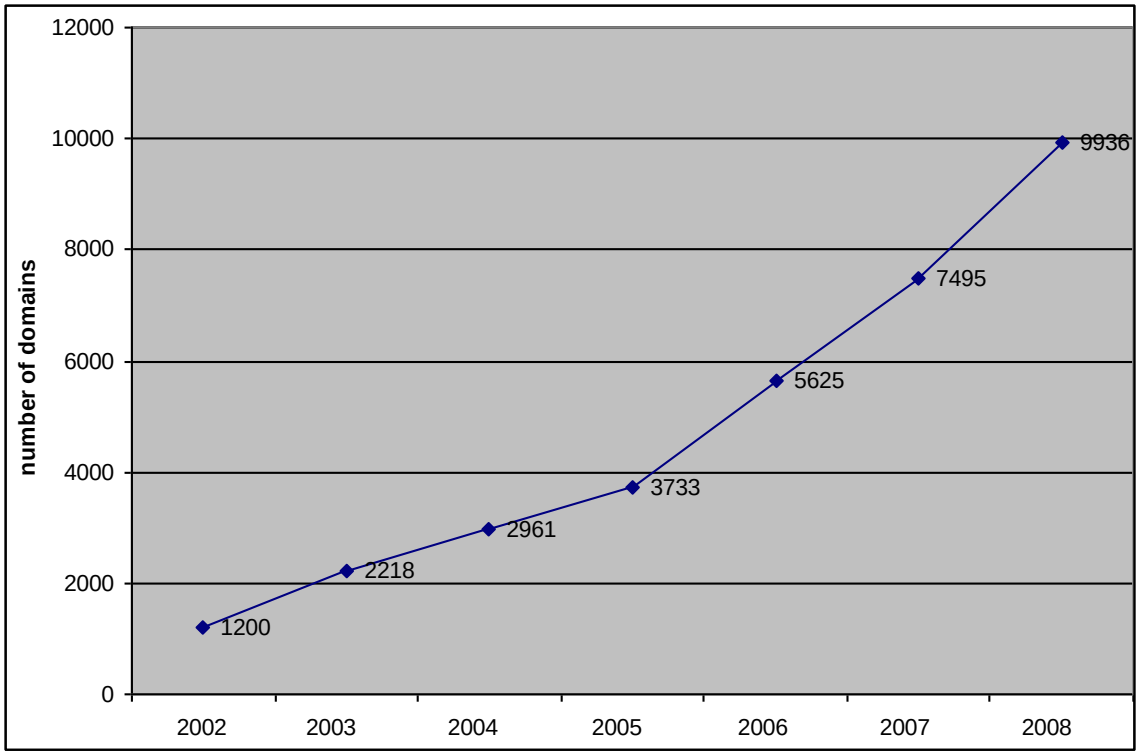
- sell this as a benefit to web owners, particularly if the focus of the content is local.

- encourage local hosting therefore create economies of scale to enhance growth of hosting industry.

The prerequisite of a growing local hosting is however predicated on infrastructure with adequate power and security. The latter needs to be addressed at a regulatory and policy level.

At about the same time that KIXP was established, Kenya launched a DNS management infrastructure under the name Kenya Network Information Centre (KENIC) in 2001. KENIC embarked on an aggressive campaign to create awareness of the dot Ke domain, whilst simultaneously encouraging Kenyan organisations to register their websites under the dot ke domain. While hosting of content locally was not a key objective of KENIC, the awareness creation had a potent message of local hosting of content. Since 2001, the number of domains registered has increased to close to 10,000 as indicated in Chart 10 below.

Chart 10: Kenya: Growth of locally registered domain names (2002-2008)



Source: KENIC

KENIC has created awareness to register domains locally by evocative appeal to national pride and as an aside, a subtle message to host the content locally. There is an obvious advantage to registering under a local domain name and host locally. DNS resolution is demonstrably faster courtesy of KIXP exchanging traffic to KENIC directly and the access speeds to local content is just as fast

However, there are challenges that reduce the interest in hosting content locally. Interviews with content developers indicate that hosting content has some challenges that include:

- economics – hosting content locally is twice as expensive as hosting content abroad.

- uptime – while the Kenyan infrastructure has improved tremendously, some level of infrastructure failures occurs and the impact is worrying and especially for sensitive transactional data.

- security – policy, regulatory and operational infrastructure is not yet in place to create and enforce processes and standards that can be audited.

- Access speeds – this is clearly an advantage for hosting locally but awareness has not been sufficiently raised to build a competitive advantage around it.

Faced with these challenges, a number of local companies prefer to host abroad, if the client insist on hosting locally, then the company recommends that the client company host the server in their own premises.

3. Case study three: South Africa

3.1 Background to the setting up of South Africa's IXPs

The Internet was officially launched in South Africa in 1994. As the Internet grew, 4 or 5 major ISPs emerged that found it expedient to develop local private peering links with one another. As the largest 5 ISPs carried 80% of the local traffic at the time, it made sense to develop the most efficient means of routing traffic. The philosophy behind peering was principally to supply the most technically efficient links possible between the different service providers in order to exchange local traffic between them.

There were no commercial objectives involved and subsequently, the costs were shared among the group of ISPs. The concept of an Internet Exchange Point (IXP) was raised some time after the establishment of these private peering relationships, once the community of 2nd Tier ISPs began to grow. Telkom Internet (the incumbent operator's internet service provider operation) was not one of the private peering partners at the time.

Pressure from Tier 2 ISPs caused the Internet Service Providers Association (ISPA) to consider means by which they could facilitate peering between the smaller ISPs and the larger ISPs in order to reduce connection costs and become more competitive. Out of these discussions, the Johannesburg Internet Exchange (JINX) was formed in 1996.

A Cape Town Internet Exchange (CINX) was also set up but was suspended due to lack of support from the ISP community. However, there is a renewed attempt to resurrect CINX. Pressure is coming from service providers that wish to peer with Tier 1 SPs in Cape Town as well as large content providers which plan to cache content in Cape Town. Traffic between local ISPs and ISPA members is currently being routed through JINX. Cape Town ISPs will be able to route local traffic close to home without having to lease links to Johannesburg.

The other player involved in internet exchange traffic is the South African Internet Exchange (SAIX). It specialises in the provision of Tier 1 access for ISPs which on-sell access to Tier 2 ISPs. SAIX builds, manages and maintains the national and international IP network for South Africa's incumbent telecoms provider, Telkom. SAIX provides access to more than two-thirds of South Africa's ISPs on a commercial basis.

The difference between SAIX and JINX is that SAIX operates as a commercial entity, and recovers revenue from the ISPs that it peers with on the basis of transit costs when international links are used to access the world-wide web. JINX, on the other hand, operates as a non-profit organisation and does not charge access fees.

The Internet Service Providers' Association (ISPA) is a non-profit South African Internet industry organisation. It was formed in June 1996 and

currently represents over 150 Internet service providers with a diverse range of services and target markets. Members include non-profit providers and educational networks, as well as commercial service providers. ISPA is administered by a Management Committee, consisting of representatives from ISPA member organisations. The Management Committee is elected by members at ISPA's annual general meeting.

ISPA currently has 158 members segmented into Large, Medium and Small members. There are also four honorary members in the association. The major ISPA members are listed below. Its large members are: AT&T SA, CMC Networks, DataPro, Gateway Communications, iBurst, Internet Solutions, MTN Network Solutions, MWEB, Neotel, Posix Systems, Sentech, T-Systems, UniForum SA, Verizon Business and Web Africa. Its medium category members are: ALTONet, Dotcoza, Ensync Business Solutions, iSAT, Jireh Technologies, SAI Futurenet, SITA (State IT Agency), Technology Concepts and TelFree Communications. There are 119 small category members.

In order to connect to JINX, an ISP needs to have been a member of ISPA for at least one month. Membership of ISPA is open to any ISP in Southern Africa. All members of ISPA may connect to JINX, but medium-sized members are restricted to connections of up to 512kbps at JINX and small members are restricted to connections of up to 128kbps. Details of membership fees and other costs associated with JINX are provided below. ISPs outside of South Africa but within Southern Africa may join ISPA as non-voting international members. They have the same access to the IXPs and pay the same fees as other members, based on their size.

There are three cost components relating to JINX. Its users must pay the appropriate ISPA membership fees and a JINX joining fee. JINX users connecting to JINX via means other than circuits leased from a licensed telecommunications operator may also be liable for equivalent line charges.

Each category of ISPA membership carries a monthly or annual fee[11], as indicated below. All prices are provided exclusive of 14% VAT.

- Large JINX (unlimited) - ZAR6,100 / month
- Medium JINX (up to 512kbs) ZAR1,500 / month
- Small JINX (up to 128kbs) ZAR350 / month or ZAR3,360 / year (offering an effective discount of 20% if membership fees are paid annually)

In addition to ISPA's membership fees, JINX participants must also pay JINX joining fee. These fees are presented below, exclusive of 14% VAT.

- Large JINX (unlimited) ZAR25,000
- Medium JINX (up to 512kbs) ZAR10,000

[11] The exchange rate at the time of writing fluctuated at around ZAR 10 = 1 US$.

- Small JINX (up to 128kbs) ZAR2,500

This is a one-time, non-refundable fee, which may be paid in ten instalments. Members upgrading their size category need only pay the difference between the two joining fees. The same terms and conditions apply to all members using JINX. A connection to JINX does not imply that other ISPA members will exchange traffic with any or all members on the SP's network. Traffic exchange agreements must be negotiated with other JINX users.

Equivalent line charges were introduced in order to remove the unfair advantage some ISPs had over others. Most participants must lease data lines to connect to JINX, but ISPA members located in the same building as the JINX can connect to the exchange at a minimal cost, as they do not need to lease additional lines. The equivalent line charges are intended to ensure that JINX participants enjoy equitable and fair access to JINX.

An equivalent line charge applies when a JINX participant connects to JINX using any infrastructure that does not carry a public tariff. This does not affect ISPs connecting to JINX via Telkom lines or via any other publicly advertised telecommunications service.

The equivalent line charge is based on the traffic measured at the switch port(s) of any ISPA member meeting the above criteria. Traffic exchanged directly between JINX participants at JINX is not subject to any charge. ISPA members may negotiate alternative settlements with other peers in order to bypass the equivalent line charges.
The following exhibit lists the monthly traffic fees levied by ISPA in the form of equivalent line charges. The charges are fixed for the period 2006 to 2009, but may be decreased following a review at the discretion of the ISPA Management Committee.

Table 10: South Africa – JINX equivalent line charges (excl. VAT) (2006 – 2008)

Monitored Traffic	Monthly Fee (in ZAR)
0 Mbps - 2 Mbps	0
2 Mbps - 8 Mbps	22,000
8 Mbps - 34 Mbps	51,000
34 Mbps - 50 Mbps	67,500
50 Mbps - 75 Mbps	94,000
75 Mbps - 100 Mbps > 1,000	120,500
100 Mbps - 150 Mbps	157,500
150 Mbps - 200 Mbps	190,000
200 Mbps - 300 Mbps	255,000
300 Mbps - 500 Mbps	375,000

Source: ISPA, 2008

The equivalent line fees are loosely based on the estimated data line costs for lines capable of carrying monitored traffic levels. Estimated installation costs for these lines have been amortised over 36 months and added to the monthly cost.

ISPA has called for proposals from companies interested in hosting the JINX from 2009 to 2012. In 1996, JINX's four links handled speeds varying from 64kbps to 256kbps. In 2008, speeds of more than 20 links vary from 2Mbps to 1Gbps, with an upgrade to 10Gbps to be implemented in the near future.

Internet Solutions has hosted JINX until now, but it is felt that it is time to award the hosting function to another properly equipped ISP in the interest of fairness. According to IS, the host normally bears at least part of the cost of hosting the IXP but the function is considered to be prestigious and desirable from below-the-line marketing perspective.

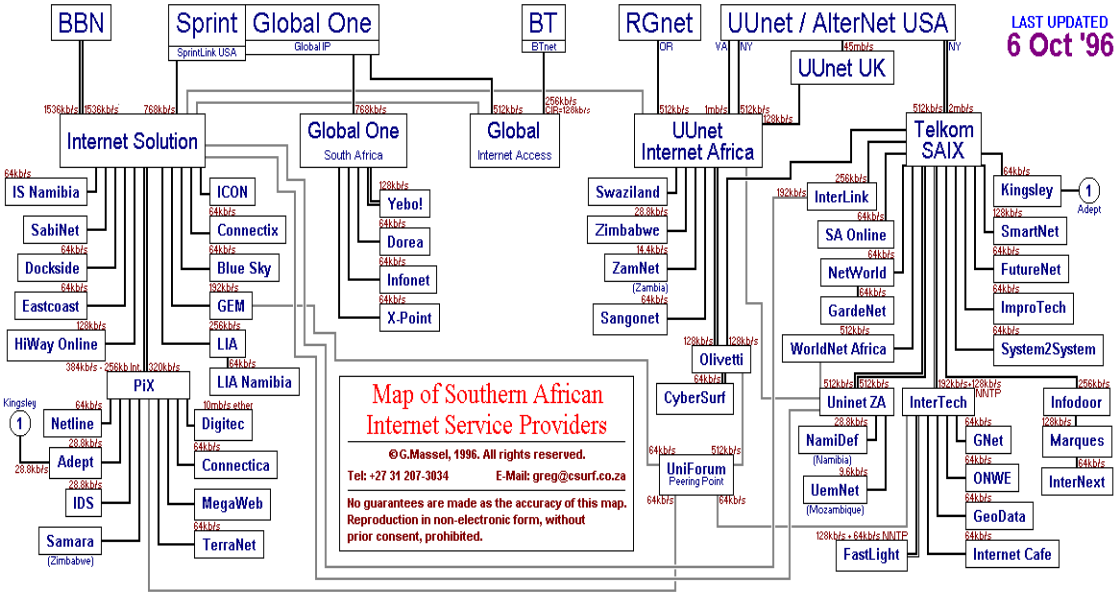
Prospective JINX hosts must be able to offer 24-hour on-site access for all ISPA members using JINX. The host's data centre will need to offer fully redundant air-conditioning systems, UPS and power reticulation systems as well as back-up generators, and fire protection systems. The site must also provide full access to the services of existing and future Electronic Communications Network Service (ECNS) providers. The host must be able to provide sufficient space for eight racks growing to twelve over a three-year period, with a right of refusal for a further four.

In addition, the host should be able to provide additional hosting space on request to ISPA members requiring additional space beyond that offered by ISPA at JINX. Proposals will be considered from ISPA members as well as non-members.

The following ISPs are connected to JINX: About IT, Altonet, AT&T, DOTCOZA, iBurst, ICOZA, Internet Solutions, ISC F-Root, MTN Networks, MWEB, Neotel, PCH, Posix, TENET, UltraDNS, Uniforum, Verizon, Vox (DataPro) and Vox (Storm).

The following diagram show how the IXP has been integrated with the ISPs and the peering links. The first diagram, dated October 1996, shows the peering links before JINX was established:

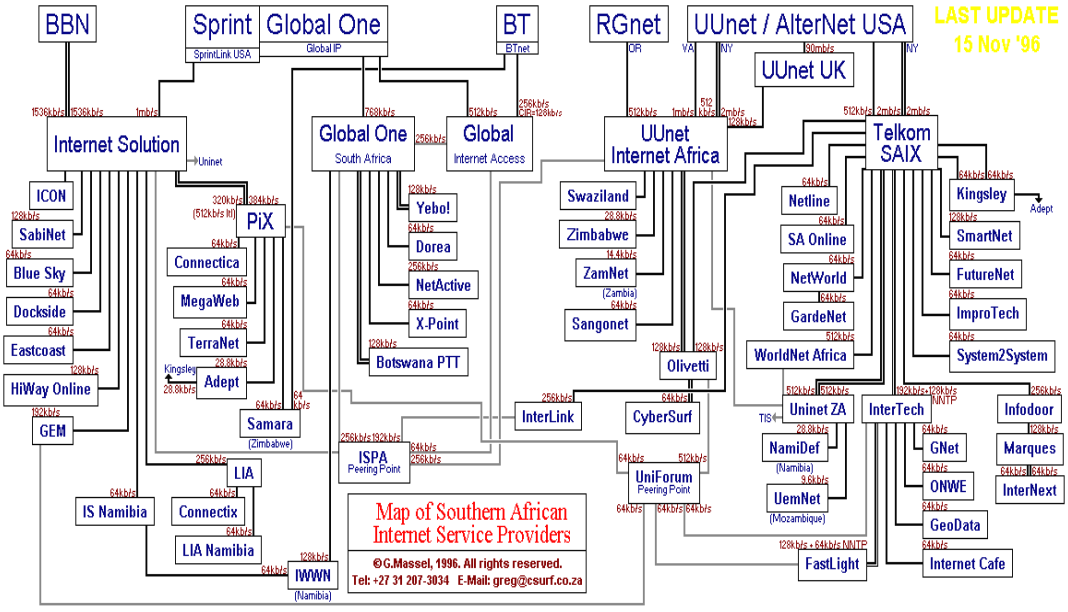
Diagram 3: Map of Southern African Internet Service Providers links prior to JINX launch (October 1996)



Source: Greg Massel, 1996

The diagram below dated November 1996, shows the peering links with the addition of the newly-formed JINX (labelled as ISPA Peering Point):

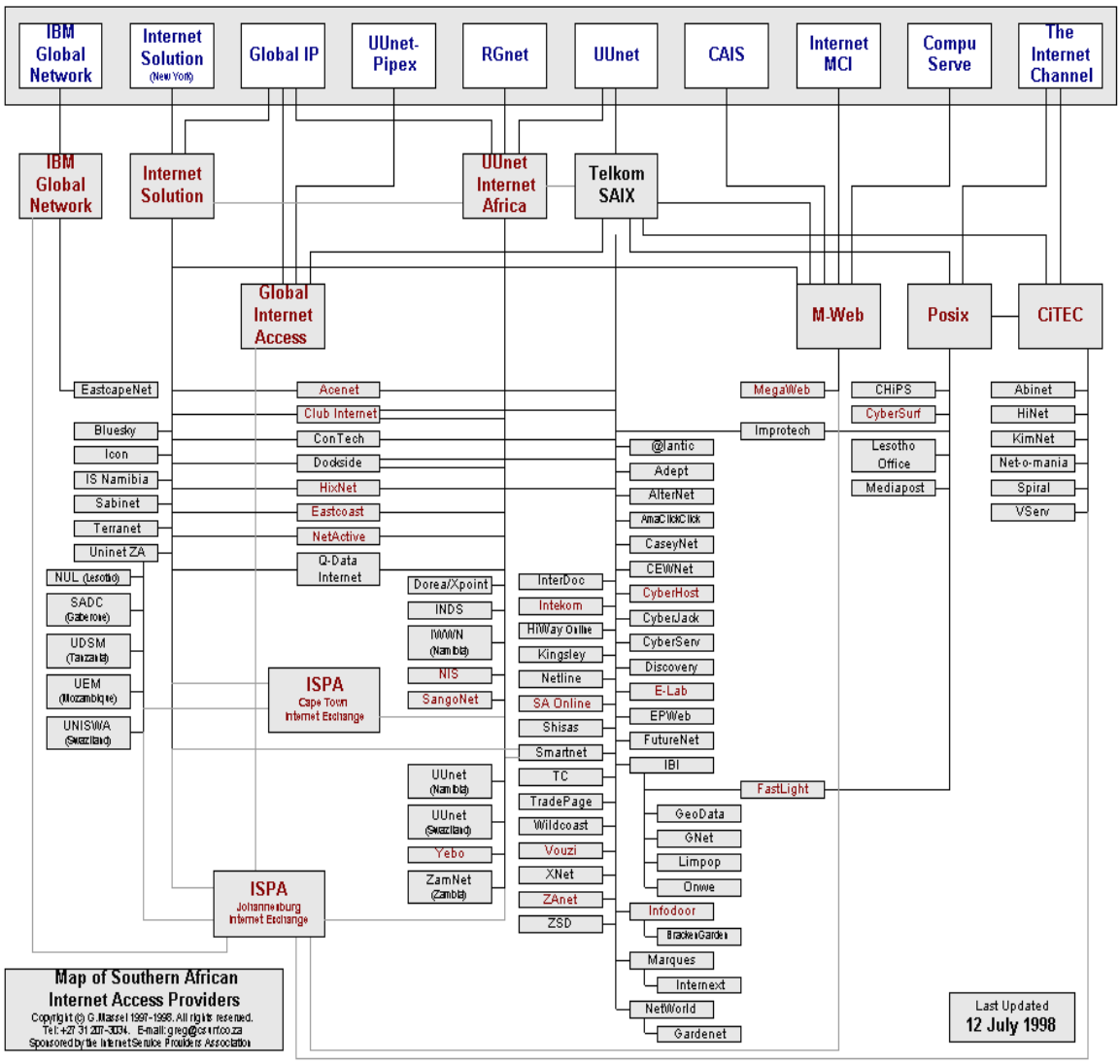
Diagram 4: Map of Southern African Internet Service Providers links prior to JINX launch (November 1996)



Source: Greg Massel, 1996

The last diagram shows the interaction of both JINX (labelled as ISPA Johannesburg) as well as CINX (labelled as ISPA Cape Town) along with the peering points of the local ISPs.

Diagram 5: Map of Southern African Internet Service Providers links to JINX (1998)



3.2 Impact of IXP on pricing of Internet

As discussed above, the major ISPs established private peering relationships among themselves as a result of expediency. The largest local use for transfer of traffic was local e-mail. As the largest 5 ISPs carried 80% of the local traffic at the time, it made sense to develop the most efficient means of routing this traffic. The cost savings generated by these ISPs have been described by interviewees as insignificant, which confirms the view that peering was not undertaken for commercial reasons. It would appear that the major benefit to peering was for technical efficiency. When the IXPs were introduction, the Tier 1 ISPs felt there were no commercial reasons to connect to them.

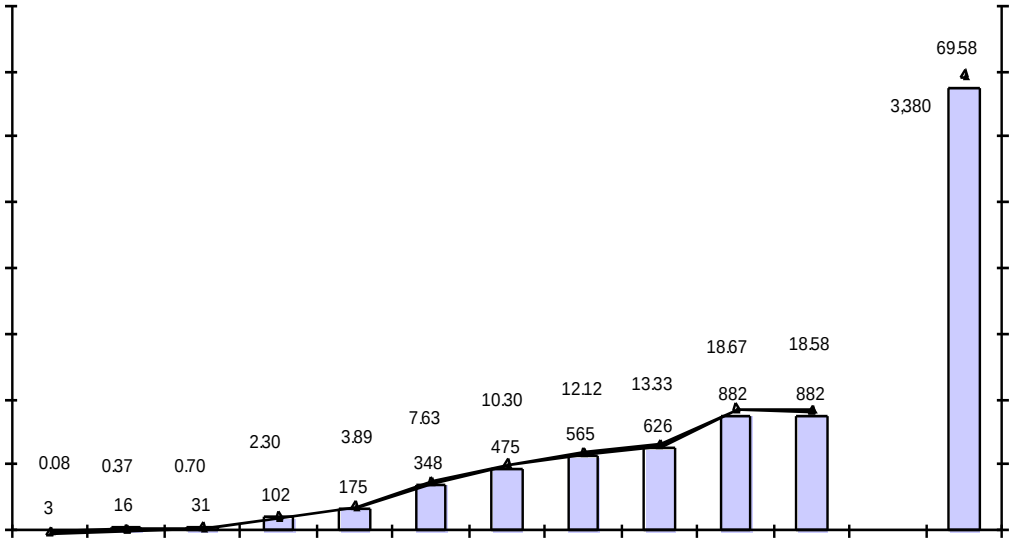
The introduction of the IXPs was most beneficial for the Tier 2 ISPs which purchased services from Tier 1 ISPs. The need to peer with the larger players would have necessitated the installation of private peering links at considerable cost. The IXPs allowed for private peering to be effected at much lower cost. Instead of leasing separate links (leased lines) for peering

with multiple service providers in the market, Tier 2 ISPs can achieve the same objective of exchanging local traffic by connecting with only a single link into the IXP. This allows for the Tier 2 ISPs to be a more effective competitive force in the market place.

During the course of the interviews with the relevant service providers, it was pointed out that the cost saving attributable to peering at the IXPs was in fact insignificant. Cost savings that were realised by the ISPs did not translate into savings passed on to the end users, but were rather manifested in an improved quality of service. The general view is that over time the end user received a better service for his money rather than receiving the same service for less.

The following chart indicates the growth in international Internet bandwidth for South Africa as well as international internet bandwidth per inhabitant (data for 2006 is not available).

Chart 11: South Africa – International Internet bandwidth (1995-2007)



Source: ITU

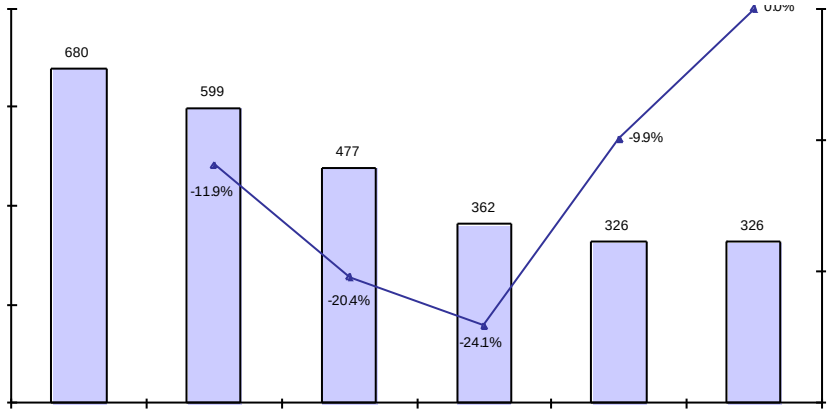
Due to the fact that prices for dial-up services have changed little over the past ten years or so, the end user has actually realised savings in real terms, since annual inflation during the period has oscillated between 3.9% and 9.3%.

Whilst the price of dial-up services has not been subject to demonstrable change over the past decade, a decline in the cost of broadband services has certainly been observed since their introduction in late 2002.

For example, the retail cost of a DSL512 line has decreased by 52% over the past five years, declining at a CAGR of -13.7%. The following exhibit provides

an indication of the decrease in the DSL512 line tariff (no internet access or data package included).

Table 11: South Africa - Retail cost of DSL512 line (2003 – 2008)



Source: Telkom SA press releases, 2004 - 2008

The preceding discussion has shown that the cost of doing business by the ISPs has not been affected significantly through the advent of the IXPs. Also, the ISPs have not passed savings on to end users in the form of lower fees and tariffs for Internet access and services. However, the end user has benefited in the form of improved and enhanced services for the same price.

Dial-up prices have not seen much variation over the past ten years or so. Any reductions in the price of services, such as broadband services, have resulted primarily from the competitive market elements rather than from cost-savings by the ISPs being passed on to the users. However, cost savings generated through the IXP and from decreasing costs of international bandwidth have allowed especially the Tier 2 ISPs to be more competitive. This in turn has allowed them greater flexibility in competing in the market and to remain profitable.

Benefits derived by the enterprise segment from implementation of the IXPs are very difficult to quantify, given the fact that they are not monetary savings derived from lower Internet access fees, but rather intangible benefits with an indirect impact on the cost of doing business. These benefits include:

- No additional or lower fees for value added services, bundled with internet access.

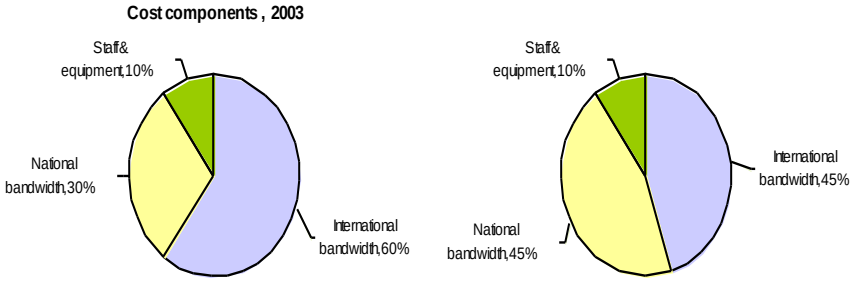
- Improved quality of service (on internet access) possibly leading to work efficiencies and effectiveness. This in turn can translate into cost savings. E.g. use of applications such as internet banking.

- Use of local rather than international bandwidth for a portion of total company traffic. (Service providers may offer a higher monthly bandwidth consumption cap limit on local traffic than on international traffic.)

In order to attempt a monetary quantification of the types of savings generated by enterprises from the abovementioned benefits, specific primary research and econometric modelling would have to be undertaken.

However, it is possible to identify the costs for national and international bandwidth as a percentage of ISPs' overall operating costs:

Chart 12: South Africa – ISP operating cost components, including bandwidth (2003 vs 2008)



Source: Africa Analysis interviews,2008

It is interesting to note that national bandwidth costs make up a larger portion of the total cost of bandwidth than international bandwidth, even though the proportion of local traffic has fallen. This is attributed to the continued fall in the cost of international bandwidth, while local bandwidth cost remains high. On the basis of the above summary, international bandwidth cost has declined by 30% in relation to the cost of local bandwidth over the past five years.

The following table provides indications in terms of bandwidth pricing offered by some of the local ISPs for dial-up services and national leased lines. Note that many products are offered as bundled services and it is difficult to strip out the various cost components in order to arrive at the pure cost of access.

Table 12: South Africa - Bandwidth cost components (cost per month) in ZAR, incl. VAT

ISP	Dial-up	Leased line (64kbps)
MWEB	145	from 1,050
Internet Solutions	Not available	from 4,000
Verizon	from 139	4,000 to 5,000
DataPro (Vox Telecom)	free / 60 / 70	over 600 different pricing options

@lantic (Vox Telecom)	55 / 90	distance based pricing
CMC Networks	Not available	different pricing options
Telkom	79	up to 50 km: 150.48 + 10.55 / km 51-200km: 482.22 + 3.90 / km
WebAfrica	85 / 97 / 194	Not available
Posix	85.50 / 171 / 285	1,500

Source: Africa Analysis interviews, SP web sites 2008

Notes on the table above:

CMC Networks – Only offers ADSL and leased lines; no dial-up service available. Leased lines are priced according to throughput and distance. DataPro (Vox Telecom Group company) – Offers a free dial-up service with an e-mail address, but the subscriber must have own modem and has to pay for the time spent online. Internet Solutions – No longer offers dial-up services, only ADSL and leased lines. The latter is prices according to throughput and distance. Verizon – Leased lines are bundled with a Telkom access line, router and bandwidth. Excluding the router, the cost is ZAR 4,000 per month.

The concept of bundling comes into play in this analysis, as access to the Internet has become commoditised with there being little value in the user simply having access. The move to bundled services has been adopted by most if not all ISPs, with access being the basic component. Access has been coupled to a variety of value-added services such as spam filtering, anti-virus and fax facilities to name a few. It is fair to say that the access prices have not changed much over the years, but additional value-added services have been added at no additional cost. This enhances the view that the end user had been given a better overall Internet experience at no additional cost and have thus benefited.

3.3 Other impacts (speed of access, traffic volumes and local content)

Generally, dial-up is limited to 56kbps (maximum), with the ISDN links available either at 64kbps or 128kbps. Both services are offered on a best-efforts basis. Leased line speeds vary from 64kbps to 2Mbps. The following exhibit provides an indication of bandwidth speeds offered by some of the local ISPs on dial-up and leased line services.

Table 13: South Africa: Bandwidth dial-up and leased line speeds offered

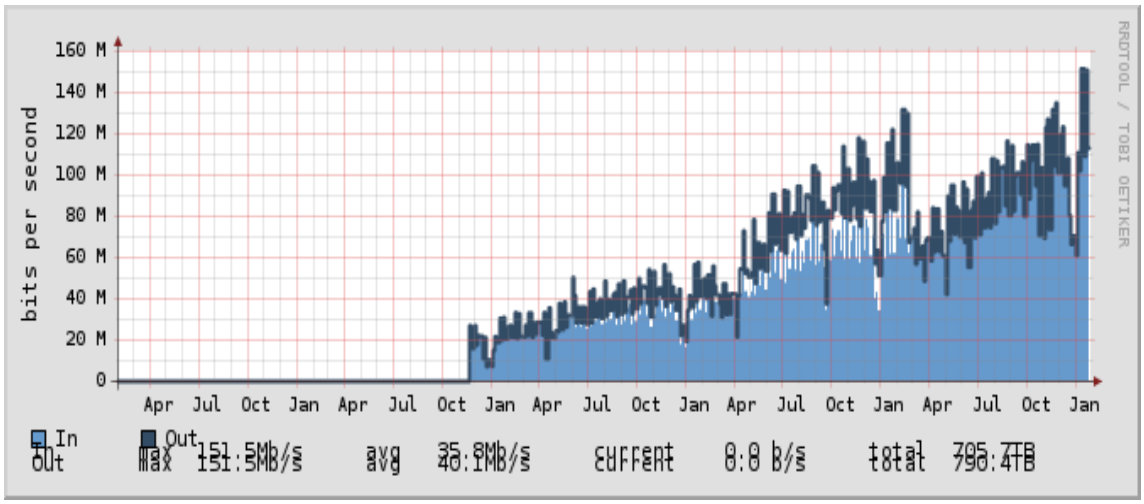
ISP	Dial-up	Leased line
MWEB	56kbps	64kbps to 2Mbps
MTN NS	Not available	from 128kbps to 4Mbps
Internet Solutions	Not available	from 128kbps
Verizon	56kbps, up to 128kbps (ISDN)	64kbps
Telkom	56kbps	64kbps to 2Mbps
DataPro (Vox Telecom)	32 to 64kbps	from 64kbps

Atlantic	128kbps (ISDN)	64kbps to 2Mbps
WebAfrica	56kbps, 64kbps, 128kbps (ISDN)	Not available
AT&T SA	56kbps, 64kbps, 128kbps(ISDN)	64kbps
Posix	64kbps and 128kbps(ISDN	64kbps

Source: Africa Analysis interviews, SP web sites 2008

The dial-up speed has not changed substantially since the inception of commercial Internet services in South Africa. It has increased to a maximum of 56kbps. Also since South Africa is connected to an international fibre cable (SAT3) and has a national fibre network, latency is less of an issue than is currently the case for countries which rely on satellite and have a much less well developed national backbone.

Chart 13: South Africa – Total traffic through JINX (last five years)



Source: ISPA, 2009

It is estimated that the local private peering traffic volume in South Africa is approximately 1 Gbps as at Q3 2008. Of this, it is estimated that between 10-15% of local traffic passes through JINX. While Tier 1 ISPs are connected to JINX, it is clear from the discussions held that only a small portion of their traffic is routed via this IXP. The majority of their local traffic follows private peering routes.

SAIX does not peer with JINX. There are also no private peering links between SAIX and the Tier 2 ISPs. SAIX estimates that the total local traffic handled by it is between 4 Gbps and 5 Gbps, whereas the international traffic is 30 STM-1s, or 4.7 Gbps on fibre-optic cable links.

Local traffic is at present lower than it was in the early days of Internet use in the country, and certainly lower since the adoption of broadband services in South Africa. During the days of dial-up services only, local traffic consisted predominantly of e-mails and corporate traffic. With broadband proliferation, browsing of web sites has become much more common and most of the content is located off-shore. The following exhibit shows details of traffic

composition as divulged in discussions with local entities. The data represents the aggregate of the various views and estimates reported.

Table 14: South Africa - Traffic composition (1999 vs 2008)

	1999	2008
Local traffic portion of total traffic in SA	50%	40%
Local traffic at JINX	50%	60%
Dial-up	No data	50%
Leased line	No data	50%
Content – local	No data	20%
Content – international	No data	80%
Caching at source (PoP)	No data	95%

Source: Africa Analysis interviews, 2008

Local content is made up primarily of eCommerce and banking services. It was pointed out in discussions that there is no broadband traffic that passes through JINX. Of the total JINX traffic, 50% is dial-up and 50% is leased line traffic. Currently there are some 700,000 dial-up subscribers in SA. The caching which is done at the international PoPs is available to ISPs locally. Content cached internationally accounts for 95% of all international content.

3.4 The impact of other factors on changes in pricing

Apart from the routing of local traffic through the IXP to generate cost savings for the ISPs and ultimately the end users of Internet services, other factors have also played a more decisive role in the reduction of fees for such services. These are discussed in this section.

Until now, the regulatory regime has not addressed the question of bandwidth pricing or broadband services specifically, so it is difficult to conclude that the regulatory environment has had a direct positive impact on the decreasing cost of broadband services by itself. The one instance where the regulatory regime has had a direct impact is in the unrestricted licensing of Value-Added Network Services (VANS). This has resulted in over 300 hundred larger and smaller ISPs offering services in the market, thus creating a relatively competitive Internet services provision market.

However, regulatory changes recently introduced are bound to have a greater impact on the Internet services provision market in the future. Under the new licensing regime, the ISPs will be allowed to self-provision their own access networks and a number of the larger ISPs are likely to do so. This will result in greater competitiveness of product / service and better ability to manage costs by the ISPs, providing them with greater flexibility in terms of profit margins.

ICASA has also been preparing for the division of vertically integrated operators into wholesale and retail operations. This means that in the future

operators selling infrastructure-based products / services will legally obligated to sell such products to all the retail service providers at the same price. This will create a more competitive environment by equalising some of the input costs for all retail service providers.

Competition in the broadband arena has intensified with the introduction of 3G services by the mobile operators into the market in 2005. This has resulted in a steady year-on-year decline of prices for broadband services. Additionally, new market players (such as Neotel) and technologies have begun to emerge which will result in further downward pressure on the price of broadband services in the future.

The cost of bandwidth to the industry was not revealed by either SAIX (Telkom SA) or by any of the other interviewed service providers. However, indications from the market are that the reductions in the cost of international bandwidth over time have not been passed on by the ISPs to the end users. According to SAIX, the cost of international bandwidth has decreased significantly over the last 2-3 years. This is confirmed to an extent by the major ISPs (IS and Verizon) which indicate that Telkom has been reducing its price of international bandwidth sold to the ISPs by an average of 10% annually over the past several years. They also claim that the cost savings derived from lower bandwidth costs have been passed on to their customers.

The major ISPs interviewed (IS and Verizon) have indicated that the contention ratios on dial-up have decreased over the past few years largely as a result of the fall-off in subscriber numbers. Similarly, contention ratios for ADSL have increased over the last few years as a result of increasing subscriber numbers coupled with a more recent drop in the cost of bandwidth on broadband.

The increased availability of local content has increased the volume of local traffic significantly, which means that contention for local bandwidth has increased relative to international bandwidth.

To date, technological advancements in the SA market have had limited impact on the cost of providing internet and broadband services. Reductions that have occurred have resulted primarily from the competitive environment. However, current and future deployments of NGN and new access network technologies will result in operational cost savings for operators, resulting from more efficient network utilisation. This may influence the cost of internet access for end users, allowing the service providers to lower the cost without a corresponding sacrifice of profit margins.

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