International Telecommunication Union

Via Africa

Creating local and regional IXPs to save money and bandwidth

Discussion paper prepared for IDRC and ITU for the 2004 Global Symposium for Regulators

IDRC CRDI
Canada

International Telecommunication Union

Via Africa

Creating local and regional IXPs to save money and bandwidth

Discussion paper prepared for IDRC and ITU for the 2004 Global Symposium for Regulators

IDRC CRDI
Canada

International Telecommunication Union

Acknowledgements

This 2004 Global Symposium for Regulators (GSR) Discussion Paper was prepared by Russell Southwood, CEO, Balancing Act, upon the request of the Telecommunication Development Bureau (BDT) of the International Telecommunication Union (ITU) and the International Development Research Centre (IDRC). Following a comment period that closed on 30 December 2004, this paper has been released for final publication as a joint publication of IDRC and ITU. The views expressed in this paper are those of the author and do not necessarily reflect the views of ITU or its members.

IDRC is a Canadian public corporation that works in close collaboration with researchers from the developing world in their search for the means to build more equitable and more prosperous societies. IDRC was one of the first development agencies to embrace ICTs as a key means to foster development and alleviate poverty.

ITU is an international organization within the United Nations System where governments and the private sector coordinate global telecom networks and services. The missions of BDT include assisting developing countries in the field of information and communication technologies (ICTs), promoting the benefits of ICTs to all the world's inhabitants and promoting and participating in actions that contribute towards narrowing the digital divide, which encompasses ITU's dual responsibility as a United Nations specialized agency and an executing agency for implementing projects under the United Nations development system or other funding arrangements.

The author would like to thank the following for their contribution to the development of this discussion paper: Sunday Folayan, Paul Hamilton, Badru Ntege, Andrew McLaughlin, Bill Woodcock and others too numerous to mention. A particular thanks to Brian Longwe and William Stucke, fellow team members on the IDRC study whose help has been invaluable. Finally thanks to those who have supported its publication including Steve Song and Laurent Elder of IDRC and Jean-Yves Besnier, Desire Karyabwite and Susan Schorr of ITU BDT.

International Telecommunication Union
Place des Nations
CH-1211 Geneva
Switzerland

Table of Contents

Introduction

This discussion paper addresses two issues of direct relevance to most developing countries: the high cost of bandwidth, one of the factors inhibiting the growth of Internet usage in these countries; and one of the reasons for this high cost, the need to use international bandwidth to exchange data at a local and national level.

In June 2003 the Canadian agency International Development Research Centre (IDRC) commissioned a piece of work titled "Regional Peering Points – Creating a proof of concept hub". The work had two main objectives:

- To create a proof of concept regional peering point that can act as a demonstration of what might be possible.
- To identify an outline vision of the best ways of handling continental Internet traffic.

Following the discussions described in section 3, ITU invited those involved to speak at a session of ITU TELECOM AFRICA in Cairo in May 2004. The idea of this jointly published booklet came out of discussions held after that session. In the meantime, IDRC[1] commissioned a second implementation phase for the work, which is now drawing to its conclusion.

ITU's commitment to encouraging the formation of IXPs comes from its Kigali Declaration[2] which recommended that the organization address this issue through a symposium and "recommend additional initiatives that reduce dependencies on non-regional services and international connectivity. Examples of such initiatives include encouraging the development of local content and services (e.g. local free e-mail services)".

This Declaration's intent is echoed in the draft WSIS Plan of Action that calls for those involved in the process to "optimise connectivity among major information networks by encouraging the creation and development of regional ICT backbones and Internet Exchange Points, to reduce interconnection costs and broaden network access."[3]

This booklet has three sections that seek to look at how national and regional IXPs might be created, particularly in the African context but it also draws on lessons from elsewhere:

Section One looks at the African policy context out of which IXPs came and outlines the practical reasons for implementing them on the continent.

Section Two describes how national IXPs have been set up and deals with both the people and technology issues that have to be addressed. It also identifies ways in which the regulatory framework can be made more favourable to encourage their successful operation.

---

1 http://www.idrc.ca

2 Issued at its IP Symposium for Africa (7-9 July 2003) – see appendix A1.

3 See section C2, point J in the WSIS Draft Plan of Action – see appendix A1.

Section Three looks at the next logical step: how it might be possible to connect national IXPs so that data can flow between countries without needing to leave the continent. It summarizes: the discussions to date about the best approach to this task; the option chosen by AfrISPA; and what needs to happen to make it a reality.

The appendices of the booklet contain a list of useful documents and references (A1). Where possible, we have sought to avoid footnotes therefore most of the supporting material can be found in this section. It also contains a summary list of Internet Exchanges worldwide (A2) and a reference point for a fuller list.

1 Benefits of establishing national and regional IXPs

> *"At the moment, developing countries wishing to connect to the global Internet backbone must pay for the full costs of the international leased line to the country providing the hub. More than 90 per cent of international IP connectivity passes through North America. Once a leased line is established, traffic passes in both directions, benefiting the customers in the hub country as well as the developing country, though the costs are primarily borne by the latter. These higher costs are passed on to customers [in developing countries]. On the Internet, the net cash flow is from the developing South to the developed North."*

Yoshio Utsumi,
Secretary-General of ITU [4]

1.1 Context

There are currently ten national IXPs in Africa: Democratic Republic of Congo (DRC), Egypt, Kenya, Mozambique, Nigeria (Ibadan), Rwanda, South Africa, Tanzania, Uganda and Zimbabwe (See Box, IXPs in Africa). AfrISPA has played a key role in setting up these exchanges with support from a variety of public and private partners including the British aid ministry, DfID, and Cisco. There are currently no IXPs in francophone West Africa. However, a number of other African countries are already holding preparatory discussions. If there is a sufficiently high level of traffic to be exchanged at a local level then an IXP represents a rational solution.

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 end user sends an e-mail to Kenya, it is still the Kenyan ISP who is bearing the cost of the international connectivity, and ultimately the Kenyan end user who bears the brunt by paying higher subscriptions."

Worse still, when an African Internet user sends a message to a friend in the same city or a nearby country, that data travels all the way to London or New York before going back to that city or the nearby country. It has been estimated that this use of international bandwidth for national or regional data costs Africa in the order of USD 400 million a year. This situation has its parallel in telephony where it may be easier to route a call via Europe or the United States to a neighbouring country than to do so directly.

4 www.itu.int/itudoc/telecom/afr2004/86020_ww9.doc

IXPs in Africa, 2004

Source: Network Startup Resource Center (at http://nsrc.org/AFRICA/afr_ix.html).

Whereas voice transactions are made on the basis of each side involved paying for a half circuit, Internet transactions are based on a full circuit. These differences have been the subject of some debate in ITU-T Study Group 3.

The Internet Backbone Providers in the developed world respond that they do not charge developing country ISPs any more than their other customers. They believe that the majority of international costs are incurred for a number of reasons including: poor telecoms infrastructure at a regional and national level, fewer peering points than elsewhere and a genuine lack of competition in many developing countries.

In short, if Africa had a greater ability to exchange traffic locally at a national level and regionally within the continent, it would not be paying for expensive international bandwidth to make this happen. Likewise, if it had more outgoing traffic and some regional carriers, these would be able to peer with their international equivalents and lower the costs of international bandwidth. (See box, What is peering?) Continental interconnection within Africa would enable the African ISPs to aggregate intra-African traffic and negotiate better transit prices from the global backbone providers.[5]

---

5 New Strategy for Regional Interconnection in Africa, Andrew McLaughlin, XDev – Extreme Development, 24 October 2003 (http://cyber.law.harvard.edu/xdev/000046.html).

What is peering?

A relationship between two or more small- or medium-sized ISPs in which the ISPs create a direct link between each other and agree to forward each other's packets directly across this link instead of using the standard Internet backbone. For example, suppose a client of ISP X wants to access a website hosted by ISP Y. If X and Y have a peering relationship, the HTTP packets will travel directly between the two ISPs. In general, this results in faster access since there are fewer hops. And for the ISPs, it's more economical because they don't need to pay fees to a third-party Network Service Provider (NSP).

Peering can also involve more than two ISPs, in which case all traffic destined for any of the ISPs is first routed to a central exchange, called a peering point, and then forwarded to the final destination. In a regional area, some ISPs exchange local peering arrangements instead of or in addition to peering with a backbone ISP. In some cases, peering charges include transit charges, or the actual line access charge to the larger network.

Sources: Webopedia, Whatis.com

Whilst it is possible that the method of Internet charging might be changed, it runs against the grain of how liberalized markets work, and against the tradition which has fostered the enormously rapid growth of the Internet, and would therefore be very difficult to implement and to police. As the authors of the Halfway Proposition acknowledged, a more pragmatic approach would be needed to generate practical results. They argued that national and regional Internet Exchange Points (IXPs) would dramatically lower the amount of national and inter-continental traffic that needed to leave the continent.

At a national level, the argument worked well because most ISPs were based in capital cities and could interconnect themselves relatively easily. However there remained the practical obstacle of how intra-continental traffic might be exchanged. It would be considerably less easy to exchange traffic between countries for a number of reasons.

In the absence of widespread fibre infrastructure between countries, this inter-country traffic would have to travel by satellite and to date, all the major satellite operators are run by developed world countries. It would also not be easy to create inter-country connections due to unresolved regulatory issues. To tackle these problems, the Halfway Proposition authors suggested two possible options.

The first of these was to set up a Pan-African Virtual Internet Exchange (PAVIX) as a separate “for profit” organisation whose sole aim would be to link IXPs across the continent. Or alternatively to encourage the emergence of regional carriers who would establish interconnection agreements with ISPs in countries that have IXPs and then sell transit traffic to ISPs from different countries. These two options formed the starting point of the IDRC study and the outcomes of that study are described in Section 3 below.

There are a number of advantages to creating IXPs that include: cost savings, increased access speeds and reduced latency and the revenue opportunities of local content and services. These are described in the three sections that follow.

1.2 Cost savings

The underlying rationale for national IXPs producing cost savings is best illustrated by comparing the costs of local and international bandwidth:

Table 1: Local versus international bandwidth comparisons

Bandwidth	International	Local
64 K	USD 1 687	USD 190
128 K	USD 2 386	USD 274
256 K	USD 3 375	USD 378
512 K	USD 4 773	USD 535
1 MB	USD 6 750	USD 757

Source: Telkom Kenya Bandwidth Tariffs December 2001.

Before the Kenyan IXP (KIXP) was established, international connectivity charges were nine times their equivalent local costs. Although there were many market factors involved, within a very short time of the establishment of KIXP international bandwidth rates in Kenya were reduced. However exchanging local traffic through KIXP remains considerably cheaper than doing the same using international bandwidth.

Aubin Kashoba, President of DRC's ISPA-DRC said that: "The use of the Internet as a medium of exchange and the transfer of knowledge posed several problems. The current time and costs of international bandwidth was a serious handicap. The existence of a local IXP in the DRC contributes considerably to the lowering of these costs."

The local traffic flowing through national IXPs as a proportion of overall traffic varies from country to country. In broad terms, the more developed a country's (Internet) economy, the greater the proportion of traffic that will remain at a local level. For example most estimates of local traffic in South Africa going via the Johannesburg exchange (JINX) are around 50 per cent of total traffic. Whereas in Kenya, the proportion of local traffic is between 25-30 per cent. Based on these figures, it is not hard to see that substantial cost-savings can be made with local IXPs.

The rationale for reduced costs using a regional IXP can again best be illustrated by comparing bandwidth costs over different distances:

Table 2: Comparative rates over different distances

Local (single city)	USD 60 per month per 64 kbit/s
National (long distance)	USD 300 per month per 64 kbit/s
International (equivalent distance)	USD 1 000 per month per 64 kbit/s

Source: William Stucke.

In the example given above (based on South African rates from 2003) there is the same clear cost differential between local and international traffic: the cost of transporting local traffic is 17 times lower than international traffic.

But also interestingly the cost of bandwidth over considerable distances nationally is about a third of its international equivalent. In this instance the international rate might cover linking two countries that were the same distance apart as those cities linked using national bandwidth.

Here the argument is more complex than for the local versus international cost savings as several factors affect the question. For most African countries, the international gateway that would be used to carry data to other African countries remains in the hands of a monopoly. As a result, there is no competition on rates and therefore prices remain artificially high. This is currently beginning to change as many countries revise their competition frameworks as exclusivities granted to incumbents come to an end.

Also in practical terms (with the exception of the SADC region) there are very few inter-country links and only a minority of African countries are linked by fibre, which can be significantly cheaper than its satellite equivalent. Where fibre does exist as in the case of SAT-3 it is in the hands of the same (largely) monopoly incumbent telcos and as a result prices seem to be higher from some countries than they might otherwise be in a more competitive environment.

It is technically not difficult to connect up the different local IXPs (see section 3 below). So for example, with these connections in place, Mozambique's Internet users could both e-mail and access the web in, say, South Africa without the traffic this generates leaving the continent, thus saving one of Africa's poorer countries much needed hard currency.

1.3 Improved access speeds and reduced latency

One of the difficulties that comes with using international bandwidth for exchanging local traffic is that it slows down the exchange of traffic and makes the use of bandwidth-heavy applications practically impossible. The distances involved create a noticeable delay similar in nature to the delay often experienced on international phone calls.

Latency is the time it takes for a message to traverse the system from the sender to the intended point of delivery. Therefore in practical terms, the delay may be caused by a number of related factors. In being transferred internationally, the message may make several "hops". In computer networking, a hop represents one portion of the path between source and destination. When communicating over the Internet, for example, data passes through a number of intermediate devices (like routers) rather than flowing directly over a single wire. Each such device causes data to "hop" between one point-to-point network connection and another.

Delays are due to three causes: the time taken to process each packet by each router; the time taken for the packet to queue for entry into the cable connecting to the next hop (a function of how congested the connection is); and the physical transmission time from one end to the other of each connection. (This is much higher for satellite than for fibre.) The more "hops" the greater the delay. The more congested a connection, the greater the delay – sometimes by orders of magnitude more. Obviously a message sent via a local IXP to a local destination will need far fewer hops than one sent via London or New York.

Speed of transfer is also affected by throughput. If the message is transferred via satellite and there is a great deal of traffic being transferred at the same time, the rate of transfer will slow down. And as a result the message will travel significantly less fast to its destination.

Latency measures these delays in milliseconds and this might sound like an almost unnoticeable delay but the amounts add up and can considerably slow down the effective operation of things. For example, a local data transfer (perhaps an e-mail) from one side of Kinshasa to another over a satellite link may incur an average latency of 200-900 milliseconds per packet, where the message transfer involves at least seven packets even for the smallest message. By contrast, the same message transferred locally over a copper, wireless or fibre optic link will only incur an average latency of between 5-20 milliseconds. This is of no great significance for e-mail, which isn't time dependent. However, for web browsing, e-commerce, or especially for "real time" protocols, like Instant Messaging, Internet relay chat (IRC), audio and video streaming, and voice over Internet Protocol (VoIP), it becomes highly significant.

Practical performance tests show that latency using IXPs may not perform as well as this theoretical average but they still achieve considerable improvements over international transfer. For example, with 10 ISPs connected KIXP achieves 30-60 milliseconds on an uncongested link.

Obviously the participating ISPs have to ensure there is sufficient capacity to provide an uncongested link. In the early days of KIXP one rather conservative ISP decided that it would only require a 64k circuit to handle likely traffic and within two hours there was so much traffic that it became congested. But once traffic levels have been established over time, the chances of there being a congested link are much less.

The improvements in access speeds and latency open up the possibility of a range of applications that might not otherwise be possible if the local data transfer had to travel internationally. For example, in Kenya Kiss FM launched a streaming radio service and in Uganda one of the largest types of traffic traversing UIXP is Web2SMS which allows any Internet user to send SMS for free from a web browser to mobile subscribers within Uganda.

1.4 Creating revenue opportunities through local content and services

With better access speeds and lower latency, a range of new economic opportunities open up at the local level. Whereas previously it made little or no sense to host websites locally, it becomes possible to do this without an organisation incurring penalties in performance. Because of this there is likely to be a steady increase in the number of local domain names and locally hosted sites.

A whole range of services become possible that previously would have been impossibly slow. These might include:

- Streaming Video/Audio
- Videoconferencing
- Telemedicine
- E-Commerce
- E-Learning
- E-Governance
- E-Banking

In the case of Kenya an entirely Internet-based company called MyJobsEye (http://www.myjobseye.com) was established with KIXP as a major factor in the business plan. Within a few months of going live, traffic to this website constituted approximately 40 per cent of its hosting ISP's local traffic. By this time the company had a record number of 16,000 CVs and 7,000 jobs submitted online.

What there is as yet no local solution for is the high level of use of Hotmail and Yahoo addresses by local cyber-café users with all the associated bandwidth requirements for downloading user mail from outside the country of origin. Maybe in time these domains might offer regional mirror sites but it may simply be that the operators of these web-clients do not see the need for these as they do not exist on other continents.

In summary, a strong, local Internet sector has the potential to create higher-paying jobs with increased skill levels. Domestic traffic exchange favours domestic content authoring and publishing.

2 How to create a national IXP

> *"I would like to see IXPs (regional and national) happen yesterday."*
> *Ernest Ndukwe, Chief Executive, Nigerian Communications Commission*

IXPs are the keystone of the entire Internet economy: they interconnect different parts of the Internet and they allow different ISPs to connect with each other, creating in effect a centralised clearinghouse. Routing traffic the long way round is not an efficient way to use the network and thus the IXP mantra "keep local traffic local" developed. (For a definition, see the box, What is an Internet Exchange Point (IXP)?).

What is an Internet Exchange Point (IXP)?

The term *network access point* (NAP) can also be used to refer to IXPs. A typical NAP or IXP consists of one or more cabinets that contain routing equipment belonging to the participants, plus a central switch to which all of the routers are connected. Each network operator installs a connection to the IXP and exchanges traffic with other networks through the central switch. Redundant equipment is installed in case of a failure.

2.1 People engineering vs. technology issues

National IXPs are created by competing ISPs coming together to do something that is in their mutual self-interest: lower costs for local traffic. Working with competitors is never easy at the best of times but in Africa's fiercely competitive Internet sector, it is doubly difficult. The major issue is one of building trust and cooperation. You need to be able to work with your competitors and in some countries this level of trust or cooperation has not yet been established. Getting IXPs off the ground is 10 per cent technical work and "90 per cent socio-political engineering".[6]

It is particularly important to get ("written") regulatory support for IXPs. In Kenya, those setting up the IXP understood that they had reached an agreement with the regulator to launch an IXP. The regulator, however, closed the IXP for a short period of time after it was launched. After these initial misunderstandings the IXP was given written approval by the regulator. Regulators have also acted affirmatively to launch IXPs. The Ugandan Communication Commission (UCC) was able to play a helpful role in bringing the different ISPs together as it was perceived as a neutral arbiter.

The issue of building trust and cooperation makes it important that IXPs are set up in such a way that its financial transactions and governance are completely transparent.

---

6 Description used in a presentation by AfrISPA General Manager Brian Longwe at the First Southern African Internet Forum, September 2002.

"IXP management is a delicate and fragile thing that only works if configured around the naked self-interest of the ISPs that it serves. IXPs survive and succeed only where every ISP member can be absolutely certain that its financial contributions are paying only for its fair share of the costs, and are not effectively subsidizing its competitors. That counsels in favour of transparent self-management by the member ISPs, and against any role for the government."[7]

Almost all of the current generation of IXPs are run by the local ISP association for the country concerned or by a separate organisation set up specifically to manage the IXP. For example, KIXP is run by the local industry association, the Telecommunication Service Providers of Kenya (TESPOK). But TESPOK is talking about setting up a separate organisation. Appendix A3 of this Discussion Paper contains the draft constitution and suggested charging structure of this new independent body that will run KIXP. The IXP that will be set up in Ghana will start life as a separate body from the local ISPA although there will obviously be an overlap in membership.

Table 3: Traffic flow through African IXPs

IXP	Established	No. of ISPs	Traffic volume
Johannesburg JINX	December 1996	15	45 Mbit/s
Nairobi KIXP	February 2002	13	6 Mbit/s
Maputo MOZIX	July 2002	7	4 Mbit/s
Kinshasa PdX	November 2002	4	1 Mbit/s
Cairo CR-IX	December 2002	9	
Ibadan IBIX	March 2003	2	200 kbit/s
Kampala UIXP	July 2003	5	
Dar es Salaam TIX	January 2004	10	1 Mbit/s
Mbabane SZIX	June 2004	3	128 kbit/s
Kigali	July 2004	6	400 kbit/s

Source: Packet Clearing House.
In addition there is an IXP in Zimbabwe.

2.2 Technical set-up

The technical set-up for Internet exchange points is comparatively simple. At its core are Ethernet switches and routers that direct the traffic from one ISP to another. There may be one of each, or a pair of each for redundancy.

In the case of KIXP it was based on the Layer Two Route Reflector Model (L2 RR). The L2 RR IXP uses one or two routers as dedicated route reflectors. BGP[8] has a scaling feature that allows a router to reflect the route advertisements from one BGP router to other BGP routers peering with the reflector. This allows members of the L2 RR IXP to peer with the route reflector while

[7] New Strategy for Regional Interconnection in Africa, Andrew McLaughlin, XDev – Extreme Development, 24 October 2003 (http://cyber.law.harvard.edu/xdev/000046.html).

[8] Short for Border Gateway Protocol, an exterior gateway routing protocol that enables groups of routers (called autonomous systems) to share routing information so that efficient, loop-free routes can be established. BGP is commonly used within and between Internet Service Providers (ISPs). The protocol is defined in RFC 1771.

exchanging traffic with each other's routers. Thus, each ISP has a router at the IXP, which peers with only one other router, the Route Reflector. The ISP's router advertises all the routes that that ISP carries to the IXP route reflector, and receives from the route reflector the sum of all routes advertised by all ISPs peering at the IXP. All ISPs then end up effectively peering directly with each other ("multilateral peering"), without having to set up individual peering sessions or agreements with every other ISP ("bilateral peering"). It's simple and efficient, and the maintenance costs are very low.

In this way, smaller routers can hence be used on the L2 RR IXP, reducing the cost of entry for the IXP. This model has been successfully used at the Hong Kong Internet Exchange (HKIX) and has proved to be a cost effective, reliable means of ensuring stable BGP peering.

Bilateral peering agreements are difficult to implement on a L2 RR IXP. Hence, a multilateral agreement is required. For new IXPs, this is a benefit; eliminating one of the contentious issues with ISP interconnections on IXPs.

Initial capital support is sometimes provided for the purchase of the equipment. In the case of the DRC whose IXP was launched in May 2003, it was enabled by the acquisition of routers and a switch from the Network Startup Resource Centre (NSRC), which is based at the University of Oregon[9]. In other cases Cisco donated the equipment to start the IXP.

A similar pattern has been used in parts of Europe. For example, the Foundation for Knowledge and Competence Development (KK Foundation) supported the establishment of the national exchange point in Stockholm by making a grant of 5 000 000 Swedish Kronors available to SUNET to cover some of the costs for the establishment of the exchange point and the TU-Foundation. But today it is self-funding through fees paid by ISPs connecting to the exchange.

2.3 Housing the IXP on neutral ground

Because of the potential for mistrust amongst, and competitive advantage between, the participating parties, it is particularly important that the IXP is located somewhere that is seen as "neutral". Indeed the whole operation of the IXP should seen as neutral if it is to maintain the trust required to operate successfully. However in reality where that neutral ground is found depends on a number of factors, including: the context and maturity of the industry, geographical convenience, financial support from third parties and agreement on what neutral means to the different parties involved.

Location is often an important element in being able to demonstrate the wider neutrality of the project. In one country seeking to set up an IXP, a company offered space to the IXP but as it was also an ISP it was perceived as insufficiently neutral. Eventually a location was found in a Government ICT training facility that had no associations with any of the ISPs involved. In Uganda the regulator offered space on its premises to house the IXP.

In the case of Kenya, the university was one of the first options considered, but frequent student riots which cause a lot of property damage eliminated it as a candidate. A number of offers came from certain ISPs, but these were all turned down because they were clearly not neutral and raised a lot of suspicion from other ISPs.

9 http://www.nsrc.org/

The regulator CCK was willing to offer space but its geographical location (5 km outside the central business district) was inappropriate because it would have meant greater expense to put up backhaul links for the various members. Ultimately KIXP ended up leasing office space in the city centre in a conveniently located building. Over its three years existence it has attracted a number of companies who have wanted to be close to KIXP.

South Africa's JINX started life in the equivalent of a broom closet on the 9th floor of 158 Jan Smuts Avenue. The same building also housed one of the country's larger ISPs, Internet Solutions. When it became clear that the IXP was being heavily used, indeed was critical to the operation of the Internet in South Africa, the South African ISPA (which ran the facility) tendered for someone to run it. The bidding was won by IS Solutions and it has remained in the same building, although it was long ago moved into a purpose-built room with access control, security cameras and redundant air conditioning. It is now hosted in a partition in IS's Hosting Facility, which is of world-class standard.

It is worth noting that the trigger for the tendering process was demands by some of the larger ISPs for higher levels of redundancy, which added significantly to the cost of operating JINX. The "last straw" was the simultaneous failure of two of the three air conditioners.

It is very important to ensure that the cost of operating an IXP is kept as low as possible, otherwise there will inevitably be charges that one ISP is subsidising others, which can lead to the collapse of the IXP if not managed.

2.4 Costs of setting up and operating a national IXP

Given the level of savings that IXPs can achieve, they are extremely cheap to set up and run. Typical initial capital set-up costs for an IXP are as follows:

2 x Ethernet Switch (24 x 100 Mbit/s @ USD 500)	USD 1000
2 x Cisco 1760 Dual Ethernet routers @ USD 1500	USD 3000
Related Ethernet cabling, trunking and cabinets	USD 1000
Power back-up (batteries and inverter)	USD 1500
Total:	USD 6500

Note: The above is based on the Layer Two Route-Reflector Model[10].

Obviously ISPs have to provide their own backhaul link and a 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. In this way the cost of participating is kept close to nothing at this level. In countries where the regulations do not allow ISPs to own their own backhaul link, they will be forced to lease this capacity from licensed operators.

In other countries where there is a more flexible competitive regulatory framework (for example, Uganda), ISPs can build their own infrastructure and some have laid fibre connections direct to the IXP. In other cases, the ISPs have leased fibre capacity from non-incumbent operators. In the case of Uganda, the second network operator (SNO) MTN has leased some of its fibre capacity to those who could not afford to lay their own connection.

10 Opinions differ over whether this is the best model to use as things have moved on since KIXP was set up and it is important to seek detailed technical advice from those with experience.

In most cases the IXP will charge for shelf space or not charge at all. In Kenya it is a fixed fee of USD 185 per month. But this will probably change when the new independent body takes over the running of KIXP. It will probably charge a rackspace-based fee depending on how much space the participating member takes up with its equipment.

In the case of JINX in South Africa, the initial charging model was based on what was known as an "equivalent line fee" to those participating ISPs in the building where it was based in order to not disadvantage those outside the building who had to lease a line from Telkom SA to connect. Eventually the operation of the IXP was tendered and both bidders (IS Solutions and UUNet) offered to host and meet all the minimum requirements at no charge. Ultimately IS Solutions came out on top by a narrow margin and was awarded the contract.

2.5 Obstacles to implementing IXPs

There are a number of obstacles that anyone wishing to set up a national IXP will need to negotiate. Some are substantive, whilst others are not and are generally raised by those wishing to protect the status quo. These obstacles can be summarised as follows:

- *Working with the incumbent:* In countries where international services have not been opened to competition, incumbent operators may perceive IXPs as a threat to their business. The perceived threat is the loss of international traffic that will be routed locally. In these cases (for example Kenya) the incumbent telco has often fought a bitter battle to prevent the setting up of an IXP. But in most cases (and especially where there is some element of competition) the incumbent telcos have not opposed the setting up of the IXP and in some cases (where they operate an ISP) have actually participated in the setting up of the IXP.
- *Insufficient trust:* As has already been pointed out in Section 2.1, the most significant obstacle to setting up an IXP is getting enough trust between the parties to work together. Often the "techies" in the participating companies will be happy to work together but the owners or managers are more suspicious of the implications.
- *Working with incumbent ISPs:* In some countries where the incumbent telco also has an ISP, these difficulties of trust can be particularly hard to overcome. In some cases like Senegal, the incumbent not only has its own ISP but also controls the largest share of the market. Smaller ISPs are likely to be concerned about cooperation on such an unequal basis.
- *National security:* In the case of Kenya, the incumbent telco raised the spectre of the national security implications of the IXP. However, after understanding the overriding positive implications of a national IXP, the Kenyan security services reviewed the plans and said that they were happy to see it go ahead.
- *Difficult/Unsustainable Models:* Like any other network, an IXP can be very simple or very complex. A complex model reduces the chances of sustainability and could possibly even severely lower the level of participation from local ISPs and potential members. In the case of Ghana, a model which required the IXP to build a communications network which would be used by connecting members and needed licensed wireless frequencies, investment in wireless infrastructure and choice of a location convenient for wireless transmission all led to a very contentious local debate. This was further complicated by the involvement of external "experts" who pushed the model. At the time of going to press there is still no IXP in Ghana, despite the commencement of the process in early 2004.

2.6 Lessons from outside of Africa

There are currently over 264 active Internet exchange points globally (source: Packet Clearing House, July 2004). Forty per cent of these are in the US and Canada (99 and 5 respectively), 35 per cent in Europe (93), 17 per cent in Asia (45), and 4 per cent in each of Latin America (12) and Africa/Arab States (10). Of a further 27 that are known to be planned, fifteen are in the US, five in Europe, five in Asia, one in Ghana and one in the United Arab Emirates.

Table 4: Internet Exchange Points in Latin America and the Caribbean

Country	City	Name	
Argentina	Buenos Aires	NAP CABASE	NAP CABASE
	Buenos Aires	Optiglobe Internet Exchange – Latin America	OptIX-LA
Brazil	São Paulo	PTT-ANSP/FAPESP	PTT-ANSP/FAPESP
	São Paulo	Optiglobe Internet Exchange – Latin America	OptIX-LA
	Porto Alegre	Rio Grande do Sul Internet Exchange	RSIX
	Rio De Janeiro	Optiglobe Internet Exchange – Latin America	OptIX-LA
Colombia	Bogotá	NAP-Colombia	NAP-Colombia
Chile	Santiago		
Cuba	Havana	NAP de Cuba	NAP de Cuba
Nicaragua	Managua	Nicaraguan Internet Exchange	NicIX
Peru	Lima	NAP Perú	NAP Perú
Panama	Panama		
United States	Miami	NAP of the Americas	NOTA

Source: Packet Clearing House(http://www.pch.net).

Varying commercial and technical forces have driven the creation of IXPs in different countries. Of the twelve exchanges in Latin America and the Caribbean, for example, different approaches have been taken to create each, under quite different circumstances. In Chile, the intervention of the regulator helped to facilitate the creation of the facility (source: IDRC/Atlantic Consulting[11]). In Brazil, four IXPs have been created chiefly to allow ISPs in the main cities to interconnect Internet traffic between themselves, in some cases driven by universities and academic networks, in others

11 'Desarrollo de los NAP en América del Sur, prepared for IDRC/ Institute for Connectivity in the Americas by Olga Cavalli, Jorge Crom, and Alejandro Kijak of Atlantic Consulting (http://www.icamericas.net).

by private companies. In Peru and Colombia IXPs have been established in order to save on the high costs of international bandwidth. This situation is especially pronounced in Paraguay where an IXP is being established that does not have direct access to submarine cable; with the cost of international bandwidth increased by satellite prices there is an economic imperative to create a national IXP.

Meetings have been held regarding the establishment of a regional Network Access Point (NAP) in Latin America since 2001, but to date no truly neutral facility has come into existence. Several private initiatives have been developed that can be seen as an embryonic regional Internet exchange point (RXP), including the "NAP of the Americas". Owned and operated by Terremark Worldwide Inc, the "NAP of the Americas" is a Tier-1 facility located in Miami (US), São Paulo (Brazil) and Madrid (Spain) (http://www.napoftheamericas.com). Among the main proponents of regional IXPs have been those ISPs that are active across a number of countries and therefore have interest in intra-regional traffic flows.

However, IDRC/Atlantic Consulting identifies at least two key obstacles to establishing a regional NAP in Latin America. The first is that studies have shown that just 10 per cent of Internet traffic generated in Latin America has a destination in another country within the region. A second has been a dramatic drop in the cost of international bandwidth to the US, from USD 1200 per MB per month in 2000 to USD 400 per month in 2003. This has somewhat eroded the economic imperative for the creation of a regional exchange for many operators, but the economic case for southernmost Latin American countries or inland countries without access to submarine fibre is still strong.

Within Europe, there are two large IXPs in Amsterdam and London (United Kingdom) and, AMS-IX and LINX, which have 162 and 199 participants respectively. In addition, there are another eight exchanges with a traffic volume exceeding 2 Gbit/s and many smaller exchanges (Source: Packet Clearing House). As far back as May 2001, the European Internet Exchange Association (Euro-IX) was established to coordinate technical standards across the region, develop common procedures, and share and publish statistics. Currently some 33 IXPs in 21 different European countries are affiliated members of Euro-IX, roughly one third of all the operational Internet exchange facilities. Most European exchange points are "mutual" organisations, owned equally by all the organisations that connect their networks ("peer") there.

In Asia, a number of attempts have also been made to establish a regional exchange. At a national level, IXPs have been established since 1996 in a number of the more developed countries across the region. The largest IXPs are in Seoul (Korea), Tokyo (Japan), Hong Kong, Perth (Australia), Singapore and Wellington (New Zealand). But a number are also appearing in developing countries such as Cambodia, Mongolia and Nepal.

A degree of consensus has been reached on the creation of an RXP facility, but the concept of a regional exchange has foundered so far in Asia on a number of conflicts. To some extent these mirror the contending political and commercial relationships between ISPs, carriers and regulators that exist in establishing an IXP within a country, except that they are magnified onto a regional basis to bring in political factors as well. Essentially, the proposed RXP models fall into one of two categories: either (i) adapt a large established IXP in a given city which is well served by infrastructure and has a conducive regulatory environment, or (ii) create a new facility based on experimental IP networks. The ITU Centre of Excellence in Thailand has played a leading role in working with parties and conducting research into the feasibility of RXPs.

One of the key problems was that providers were unable to reach a consensus as to which country or city should host the exchange. For example, Telstra (Australia) did make a proposal but has since abandoned it, for example, although both Shanghai and Hong Kong have also lobbied hard to become the regional hub. A number of IXPs have branded themselves in a regional fashion (e.g. "Asia-Pacific Internet Exchange, APIX" in Shanghai, China or the "Asia Regional Internet Exchange – Network Access Point", ARIX-NAP in Jakarta, Indonesia). Kilnam Chon, KAIST (Korea), Chair of the Asia Pacific Advanced Network (APAN), describes the need for such a facility and notes that "some of the national Internet exchanges could function as regional Internet exchanges. Candidate locations would include Tokyo, Seoul, Beijing, Hong Kong and Singapore. The one in Tokyo is coming close to such a neutral regional Internet exchange."

A second problem has been establishing the policy framework under which an RXP could be set up and operated. There is considerable variance in national legislation between the contending locations. And a third problem is that capacity to and from countries within Asia is either scarce or much more expensive than routes to the US. This means that accessing the RXP is less attractive to other Asian ISPs than the status quo of accessing a top-tier US Internet backbone provider (IBP). The emergence of regional carriers and regional networks is seen as key to altering the economics of a centrally located hub.

2.7 Future African IXP development at a national and local level

AfrISPA has plans to help with the setting up of an equivalent number of national IXPs over the next 2-3 years. Its second "African IXP Roadmap" was launched in December 2004 and has a specific emphasis on encouraging the setting up of IXPs in francophone countries. The next wave of IXPs is likely to include the Ghanaian IXP and a Zambian IXP.

Elsewhere in the world, IXPs have been set up in larger regional cities outside of the capital including: Zurich, Geneva, Hong Kong, Lyon, Manchester, Tampere and many US regional cities (see appendix A2). There are a number of reasons why this has occurred but probably the most significant of these is traffic-related. If there is a sufficiently high level of traffic to be exchanged at a local level then an IXP represents a rational solution.

There have been two examples of African IXPs operating in regional cities: one in Cape Town and the other in Ibadan. The Cape Town IXP closed for a mixture of reasons including ISP peering policies and insufficient traffic. One of the larger ISPs was not keen on peering with smaller ISPs without charging for it. Also the larger ISPs found it easier to make private arrangements with other ISPs.

The IXP in Ibadan is perhaps more of a pointer to the future. Nigeria is a potentially large market and may well support more than one IXP, particularly in Abuja.

But beyond exchanging traffic within cities and between cities, the next logical step is to connect up local and national IXPs with their counterparts in other countries. In this way one can rework the industry to ensure that regional traffic stays regional.

3 Connecting up national IXPs to create a regional IXP in Africa

Moving from the national to the regional level posed a number of significant challenges for those who wanted to see IXPs connected across country borders.

3.1 Finding an appropriate model

AfrISPA's Halfway Proposition policy paper identified two possible approaches to create regional links between IXPs: something called the Pan-African Virtual Exchange (PAVIX) and the use of regional carriers.

The Pan-Africa Virtual Internet Exchange (PAVIX) approach was the idea of creating a mesh of point-to-point interconnected African IXPs. Under this scheme, the Mozambique IXP (MOZIX) would have a point-to-point link to the Johannesburg IXP (JINX) and a similar link to the Kenyan IXP (UIXP) and another one to the Tanzanian IXP (TIXP). On this basis, participating ISPs would be able to negotiate direct peering with ISPs at other Internet exchanges. Eventually all IXPs in Africa would be interconnected, allowing all regional traffic to be exchanged through peering or transit agreements.

There were a number of practical problems with this approach. Some of the countries connected had monopoly international gateway providers, including until recently Kenya and South Africa. This would make direct point-to-point links in those countries very difficult. A more significant issue was whether there was enough traffic for participating ISPs to justify the cost of the links required where in all cases traffic would go by satellite. If an ISP were asked to pay for the cost of the link and was not using it or hardly using it, this would be hard to justify in commercial terms. Also ISPs would be tied into using a single link when the price of connectivity from another carrier might be cheaper.

The second of the two approaches was to encourage regional carriers to provide a service to individual ISPs in different countries through the IXPs and indeed to those countries that might not yet be connected by IXP. The regional carriers would sell regional transit to African ISPs at a lower cost than global satellite and backbone providers. If the regional carriers could provide regional transit at even a slightly lower price than the international equivalent then the proposition would begin to look attractive. Also some of the practical difficulties around regulation disappeared if the carriers in question had the relevant licences in each of the countries to be served or were able to negotiate partnerships with others who held the licences.

This approach drew strength from the fact that regional carriers are a much more important part of the Internet sector in the American, European, and Asian Internet markets. If such a development could be encouraged in Africa, then these carriers would also be able to peer effectively with international backbone providers.

3.2 The launch of AfrISPA's Request for Service

During a workshop held in Johannesburg during iWeek in September 2003, South Africa, between IXP operators, ISPs, telecommunications regulators and a number of others it was established that the most desirable solution to the problem of regional inter-connection was to attract the services of companies that could offer individual ISPs a transit service between IXPs in Africa.

It was agreed that a Request for Service would be issued by AfrISPA who stated: “With this RFS, we intend to obtain innovative and cost effective proposals that meet the requirements of the African Internet community. Since this is a new opportunity opening up in Africa’s communications sector, it will provide the successful party (or parties) entry into a market that has huge suppressed demand with plenty of growth potential.”

The RFS asked operators to provide: an overview of the proposed solution; a summary of costs; prices for the service against assumptions for different traffic levels; commercials terms and conditions; detailed service descriptions; solutions for subsequent scalability; and technology support. Three carriers submitted proposals and AfrISPA has selected two of them to provide the service described to individual ISPs. An announcement will be made shortly after this booklet is published.

3.3 Scale of traffic

The key to whether regional carriers become a significant part of the African Internet sector will be the level of traffic that needs to be carried between different countries. AfrISPA has been managing a separate project (also funded by IDRC) to research traffic levels and it had been hoped that the results would be available ahead of issuing the RFS. However they are expected to be available in the first quarter of 2005 and the aims and purposes of the project are described below.

In the absence of detailed data of this sort, it is worth summarising what is known, as this will give some indication of the likely scale of regional traffic. Global Internet Geography 2005 identifies South Africa as having 5.9 per cent of its Internet bandwidth going to other countries in Africa. This represents 52 Mbit/s out of a total of 881.5 Mbit/s, providing some inkling of the likely scale of inter-regional traffic that would justify this level of bandwidth capacity.

Also the experience from Latin America described in Section 2.6 above shows that an average of 10 per cent of Internet traffic generated in Latin America has a destination in another country within the region.

As the “export platform” for the sub-Saharan part of the continent and its largest Internet market, South Africa’s figure is likely to be one of the highest in the range. Other countries may well have percentages that range from 1-5 per cent of overall traffic. However it is clear from other parts of the developed world that growing economic integration brings with it the need for greater levels of communication between countries. Therefore the growth level of this traffic will be tied to the speed with which economic integration takes place across the continent.

AfrISPA’s African IXP Research Project[12] aims to:

- Research and measure the impact of African Internet Exchange Points on domestic and international routing economics.
- Model and investigate African Internet traffic exchange and routing data.
- Collect and archive this data.
- Encourage local and regional traffic exchange by quantifying the benefits of regional interconnection.

---

12 The Project’s Website is: http://research.afrispa.org/

Equipment has been deployed at the following exchanges: KIXP, Kenya; TIX, Tanzania; UIXP, Uganda; and MozIX, Mozambique.

A Collector Server will be deployed at each IXP and managed by the AfrISPA research group. The Collector Servers act as Netflow collectors. They will also serve looking-glass information and graph traffic volume through the collectors and the IXP's Ethernet switch. Participating Networks will export their traffic flow data in Netflow version 5 format to Collector Servers. This project will result in the production of 5 quarterly country reports and one African Internet Traffic Geometry Report.

3.4 The key role of regional carriers, fibre infrastructure and future developments

As can be seen throughout this Discussion Paper, the idea of keeping regional traffic within the continent will only be a practical reality if the price of doing so is cheaper than sending it internationally to achieve the same result. This has to be the fundamental business case for achieving this objective whatever other political considerations may apply.

Therefore it is important that all stakeholders – whether government, including regulators or the private sector – work together to achieve this goal. (The section that follows details a number of practical action points for regulators.) A number of developments need to fall into place if Africa is to take its place fully in the international Internet business.

It needs to have a number of competitive regional carriers whose role is both to exchange traffic between countries and to aggregate international traffic that can then be peered with their equivalents on other continents.

Understandably given their relatively recent appearance, African regulators have tended to concentrate on the national environment. The next stage is to look at how together they can encourage a number of regional developments including the emergence of regional carriers. The regional licensing template under discussion within the subregional regulatory body TRASA provides one approach to this task.

The cost of inter-connecting countries will not begin to fall below a certain level until more countries are connected by fibre and there is open competition for fibre provision.[13] 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 populations.

Governments and regulators can encourage private sector investment in fibre inter-connections if they are prepared to offer licences to non-traditional providers (utility and railway companies). Obviously this may compete with an existing incumbent and this is an issue that will need to be addressed.

There are two sets of concrete discussions about improving inter-connectivity between countries currently under way. Egypt's two IXPs are talking to several North African countries about enabling subregional North African traffic to stay within the continent and Egypt is positioning itself as a regional hub for North Africa and other Arab States.

---

[13] African ICT infrastructure investment options, Balancing Act for DFID, 2004.

The subregional regulatory body for East Africa – the East African Postal and Telecommunications Organisation (EARPTO) – has a working group looking at how best to address linking Kenya, Tanzania and Uganda. These discussions encompass: regulatory issues, facilitating the improvement of the network between these countries and the best ways to connect the IXPs in the three East African countries.

There also are a number of planned fibre and satellite projects which if implemented should improve connectivity between different African countries, most notably the EASSy[14] and Comtel fibre projects and the pan-African satellite project Rascom.

14 East African Submarine Cable System.

4 Regulatory issues to be addressed

Regulators can do a number of different things to encourage the setting up of IXPs. Below is a checklist of areas where they can help provide a facilitating environment:

- If invited, regulators can play a helpful role as neutral arbiter in the setting up of national IXPs: the Uganda Communications Commission and the Malaysia Communications and Multimedia Commission have both played this role.

- For regional IXPs, regulators can help clear the regulatory obstacles that exist at a subregional level working through their regional organisations. The EARPTO working party on East African links offer one approach to overcoming potential obstacles.

- For the most cost-effective connections to be made regionally between IXPs it is important that there is competition at the level of the international gateway. The opening up of VSAT use is particularly important. The recent competition framework announcements in Kenya and South Africa have opened the way for this to happen.

- Where there is no competition on either data carriage or the international gateway, it is important that the regulator makes it a central priority to lower the cost of leased lines and the cost of purchasing bandwidth through the monopoly international gateway.

- At some point in the future, setting up an IXP may require the co-location of equipment in an incumbent telco's "plant". Regulators need to ensure that this access is freely given.

- IXPs may need to obtain agreement from the regulator to start operations but it is not appropriate for them to be licensed. Since the aim is to provide a piece of "common carriage" infrastructure the purpose of which is not to make profit but to save countries hard currency, it is important that it should have no additional financial burdens imposed on it.

Regulators and governments can both create the conditions in which IXPs and RXPs can flourish; the pay-off at a national level will be lower hard currency requirements.

Appendices

A1 Background documents and references

Example of an Internet exchange point: Lyonix (http://www.lyonix.net/) (Il y a aussi un explication sur les nœuds d'échange en français.)

Global Internet Geography 2005, TeleGeography, 2004 (http://www.telegeography.com)

The Halfway Proposition, AfrISPA, 2002 (http://www.afrispa.org/Initiatives.htm)

ICT Policy Handbook, APC, 2003 (http://www.apc.org/english/rights/handbook/index.shtml)

Internet Traffic Exchange: Developments and Policy, Working Party on Telecommunication and Information Services Policies, OECD, 1998 (http://www.oecd.org/document/63/0,2340,en_2649_37441_1894655_119808_1_1_37441,00.html)

The Internet Exchange Points Directory, TeleGeography Resource (http://www.telegeography.com/products/ix/index.php). The directory covers more than 150 Internet exchanges in 53 countries. Use of the Internet Exchange Points Directory is free, but users must register.

Kigali Declaration, ITU, July 2003 (http://www.itu.int/ITU-D/e-strategy/internet/Seminars/Rwanda/Info-en.html)

New Strategy for Regional Interconnection in Africa, Andrew McLaughlin, XDev – Extreme Development, 24 October 2003 (http://cyber.law.harvard.edu/xdev/000046.html)

RFS issued by AfrISPA (http://www.afrispa.org/documents/AfricanInternet-RXP-RFS.pdf)

WSIS Draft Plan of Action, December 2003 (http://www.itu.int/wsis/)

A2 List of Internet Exchanges worldwide

A2.1 North America

Canada – The Edmonton Internet eXchange (EIX)

Canada – Montreal Internet eXchange (QIX/RISQ)

Canada – The Toronto Internet eXchange (TORIX)

Canada – The Vancouver Internet eXchange (BCIX)

US – The Anchorage Metropolitan Access Point (AMAP)

US – The Austin Metro Access Point

US – The Baltimore NAP (ABSnet)

US – The Boston Internet eXchange MXP

US – The Chicago NAP

US – The Colombus Internet eXchange (CMH-IX)

US – The Dallas MAE

US – The Denver Internet eXchange (DIX)

US – The Hawaii Internet eXchange (HIX)

US – The Houston NAP

US – The Indianapolis Internet eXchange (IndyX)

US – The Los Angeles International Internet eXchange (LAIIX)

US – The Los Angeles 6IIX eXchange points for IPv6

US – The Los Angeles MAE

US – The Mountain Area eXchange (MAX)

US – The New Mexico Internet eXchange (NMIX)

US – The New York International Internet eXchange (NYIIX)

US – NY6IX

US – The Oregon Internet eXchange (OIX)

US – The Palo Alto Internet eXchange (PAIX)

US – The Philadelphia Internet Exchange (PhIIX)

US – The Pittsburgh Internet Exchange (PITX)

US – The San Antonio Metro Access Point (PhIIX)

US – The San Jose MAE Ames (NASA)

US – The San Jose MAE West

US – The Seattle Internet Exchange (SIX)

US – The Washington DC MAE-East

US – The Washington DC Neutral NAP

US – The Vermont Internet eXchange (VIX)

US – The Virginia MAE (MAE Dulles)

A2.2 Western Europe

Austria – The Vienna Internet eXchange (VIX)

Belgium – Belnet (BNIX)

Cyprus – The Cyprus Internet eXchange (CyIX)

Denmark – Danish Internet eXchange (DIX) Lyngby

Finland – Finnish Commercial Internet eXchange (FCIX) Helsinki

Finland – The Tampere Region EXchange (TREX) Tampere

France – Paris Internet eXchange (PARIX)

France – French Global Internet eXchange (SFINX)

Germany – The Deutsche Central Internet eXchange (DE-CIX) Frankfurt

Greece – The Athens Internet eXchange (AIX)

Ireland – The Internet Neutral eXchange (INEX)

Italy – The Milan Internet eXchange (MIX)

Italy – NAP Nautilus (CASPUR)

Luxembourg – The Luxembourg Internet eXchange (LIX)

Netherlands – The Amsterdam Internet eXchange (AMS-IX)

Norway – Norwegian Internet eXchange (NIX)

Portugal – The Portuguese Internet eXchange (PIX)

Scotland – Scottish Internet Exchange (ScotIX)

Spain – El Punto Neutral Espanol (ESPANIX)

Sweden – The Netnod Internet eXchange (D-GIX)

Switzerland – The Swiss Internet eXchange (SIX)

Switzerland – Geneva Cern (CIXP)

Switzerland – Zürich Telehouse Internet Exchange (TIX)

United Kingdom – The London INternet eXchange (LINX)

United Kingdom – London Internet Providers EXchange (LIPEX)

United Kingdom – Manchester Network Access Point (MaNAP)

United Kingdom – London Network Access Point (LoNAP)

A2.3 Eastern Europe

Bulgaria – The Sofia Internet eXchange (SIX – GoCIS)

Czech Rep. – Neutral Internet eXchange (NIX) Prague

Latvia – The Global Internet eXchange (GIX) LatNet

Romania – The Bucharest Internet eXchange (BUHIX)

Russia – The Russian Institute for Russian Networks

Slovakia – The Slovak Internet eXchange (SIX)

Ukraine – The Central Ukrainian Internet exchange

A2.4 Africa

Democratic Republic of the Congo (PdX)

Egypt – CR-IX

Kenya – Kenya Internet eXchange Point (KIXP)

Mozambique – MOZambique Internet eXchange (MozIX)

Nigeria – IBadan Internet eXchange (IBIX)

Rwanda – Kigali

South Africa – Johannesburg Internet eXchange (JINX)

Swaziland – SwaZiland Internet eXchange (SZIX)

Tanzania – Tanzania Internet eXchange (TIX)

Uganda – Uganda Internet eXchange Point (UIXP)

A2.5 Asia

Australia – AusBONE (Sydney, Melbourne, Brisbane, Adelaide)

China – The Hong Kong Internet eXchange (HKIX)

Indonesia – The Indonesia Internet eXchange (iIX)

Japan – The Japanese Internet eXchange (JPIX)

Malaysia – The Kuala Lumpar Internet eXchange (KLIX)

New Zealand – The New Zealand Internet eXchange (NZIX)

Pakistan – Pakistan National Access Point (PNAP)

Philippines – The Philippines Internet eXchange (PHIX)

Saudi Arabia – The Internet Services Unit (KACST-ISU)

Singapore – SingTel IX

South Korea – The Korean Internet eXchange (KINX)

Taiwan – The Taiwan Internet eXchange (TWIX-HiNET)

Thailand – The Thailand Internet eXchange (THIX) Bangkok

Thailand – ThaiSarn Public Internet eXchange (PIE)

UAE – The Emirates Internet exchange

A2.6 South America

Brazil – An Academic Network at São Paulo (PTT-ANSP)

Chile – Chile National Access Point

Colombia – Internet Nap

Panama – Senacty

List taken from Colosource (http://www.colosource.com/ix.asp).

A3 Proposed KIXP Constitution and charges

Board recommendations:

1 The KIXP is legally constituted as a Limited Liability Company in Kenya. The current shareholding and directors need to be verified. It currently has the following members:

   1 Access Kenya

   2 Inter-Connect Limited

   3 ISP Kenya

   4 Kenyaweb

   5 Mitsuminet

   6 NairobiNet

   7 Skyweb

   8 SwiftGlobal

   9 UUNET

   10 Wananchi Online

   11 KENIC

   The 10 companies excluding KENIC are assumed to have paid their KES 150 000 Membership contribution and we propose each member receives one share of KIXP Limited.

2 Each Share shall carry one vote and the Company shall have pre-emptive rights on the share.

3 The Company has seven (7) Board Members elected by the shareholders and shall elect the Chairman, Vice Chairman and Secretary.

4 The Board of Directors shall appoint a General Manager who can be from outside the board but will sit on the board but cannot vote.

5 The GM will be responsible for presenting a business plan for the board's approval.

6 Board members shall attempt to govern the IX in accordance with technical and policy best-practices generally accepted within the global community of IX operators as represented by AfIX-TF, APOPS, Euro-IX, and similar associations.

7 From time to time, the Management of KIXP may recommend certain charges to the Technical and Operational policies of the IX to the Members. Such recommendations may only be implemented with the approval of a majority vote by the Members.

Operational recommendations:

8 General KIXP technical and operational policies shall be made publicly available on the KIXP website. (MoU)

9 The KIXP shall impose no restriction upon the types of organisation or individual who may become members and connect to the exchange.

10 The KIXP shall impose no restrictions upon the internal technical, business, or operational policies of its members.

11 The KIXP shall make no policy and establish no restrictions upon the bilateral or multilateral relationships or transactions which the members may form between each other, so long as the KIXP corporation shall not be involved.

12 Members must provide 24x7 operational contact details for the use of KIXP staff and other Members. The personnel available by this means must understand the requirements of this Memorandum of Understanding.

13 Members shall be required to sign a copy of the KIXP policies document, indicating that they understand and agree to abide by its policies, before any resources shall be allocated to them.

14 The primary means of communication with other Members will be via e-mail.

15 Members must provide an e-mail address in which requests for peering should be sent.

16 Members have a duty of confidentiality to the other KIXP Members in KIXP affairs.

17 Members must not refer their customers, or any agent of their customers, directly to KIXP member’s support staff. All queries must be directed through the KIXP technical staff.

18 Members must not carry out any illegal activities through KIXP.

19 Members must ensure that all contact information held by KIXP in connection with their Membership is correct and up to date.

20 Members shall be required to provide and maintain current technical contact information, which shall be publicly posted on the KIXP website. This information shall include at a minimum an internationally-dialable voice phone number, a NOC e-mail role account, the IP address assigned to the member at the exchange, and the member's Autonomous System Number if they have one.

21 Members shall subscribe to a KIXP e-mail list, operated by the KIXP board.

22 Members may only connect equipment that is owned and operated by that Member to KIXP. Members may not connect equipment to KIXP on behalf of third parties.

23 Members must only use IP addresses on the interface(s) of their router(s) connected to the KIXP allocated to them by the KIXP.

24 Members may only present a single MAC address to any individual KIXP port that is allocated to them.

25 It is preferred that each member have their own Autonomous System number, members without an ASN allocation will be assigned an ASN from private ASN space by the KIXP Staff. Any member who has previously been connected to the KIXP using private ASN and then later acquires their own full ASN must notify the KIXP Staff as soon as possible in order to incorporate this development into the BGP peering at KIXP.

26 Peering between Members’ routers across KIXP will be via BGP-4.

27 Members shall not generate unnecessary route flap, or advertise unnecessarily specific routes in peering sessions with other Members across KIXP.

28 Members may not advertise routes with a next-hop other than that of their own routers without the prior written permission of the advertised party, the advertisee.

29 Members may not forward traffic across KIXP unless either the traffic follows a route advertised in a peering session at KIXP or where prior written permission of the Member to whom the traffic is forwarded has been given.

30 Members must, on all interfaces connected to the KIXP, disable: Proxy ARP, ICMP redirects, CDP, IRDP, Directed broadcasts, IEEE802 Spanning Tree, Interior routing protocol broadcasts, and all other MAC layer broadcasts except ARP.

31 Members must, on all interfaces connected to KIXP, disable any duplex, speed, or other link parameter auto-sensing. Full Duplex or Half Duplex Only, Fixed.

32 Members shall not announce ("leak") prefixes including some or all of the KIXP peering LAN to other networks without explicit permission of KIXP.

33 Members must set net masks on all interfaces connected to KIXP to include the entire KIXP peering LAN.

34 Any equipment and/or cabling installed by a Member at KIXP must be clearly labelled as belonging to the Member.

35 Members will not touch equipment and/or cabling owned by other Members and installed at KIXP or in the room containing the KIXP without the explicit permission of the Member who owns the equipment.

36 Members will not install "sniffers" to monitor traffic passing through KIXP, except through their own ports. KIXP may monitor any port but will keep any information gathered confidential, except where required by law or where a violation of this Memorandum of Understanding has been determined by the KIXP Board.

37 Members will not circulate correspondence on confidential KIXP mailing lists to non-members.

38 Members must ensure that their usage of KIXP is not detrimental to the usage of the KIXP by other Members.

39 Members may not directly connect customers who are not KIXP members via circuits to their router housed in any KIXP rack.

40 Members should not routinely use the KIXP for carrying traffic between their own routers.

41 Members will be required to install routers that support the full BGP-4 standard.

42 The technical committee will set up certain monitoring features on the server at the KIXP. Certain KIXP members will be asked to have their NOCs monitor these features such that any problems can be referred to KIXP technical support personnel as quickly as possible.

Pricing recommendations:

43 The following are the proposed Charges for new customers

1	SET-UP / INSTALLATION	KES 20000
2	MONTHLY	KES 10000