

Report from the IGF Rio  
Best Practices Session:

## **Internet Traffic Exchange in Less Developed Internet Markets and the Role of Internet Exchange Points**

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## Introduction

The Internet Governance Forum (IGF) emerged from the second phase of the World Summit on Information Society (WSIS) held in 2005 in Tunis. The mandate for the IGF, set forth in Paragraph 72 of the Tunis Agenda, invited the United Nations Secretary-General to convene a new forum for Internet multi-stakeholder policy dialogue. The inaugural session of the IGF was held in 2006 in Athens, Greece, with the second meeting held in Rio De Janeiro, Brazil in November 2007.

At the Rio de Janeiro meeting, the Internet Society (ISOC) organized a Best Practice session titled “Internet Traffic Exchange in Less Developed Internet Markets and the Role of Internet Exchange Points (IXPs)”. The workshop examined the drivers that determine national, regional, and international Internet traffic exchange, primarily focusing on less developed Internet markets. Further, the session featured case studies from Latin America and Africa, highlighting the realities and challenges facing those regions in efficient delivery of Internet traffic.

Sam Paltridge from the Organization for Economic Co-operation and Development’s (OECD) Directorate of Science Technology and Industry moderated the session. The panelists included Michuki Mwangi, the CTO of the Kenyan Internet Exchange Point (KIXP), Mike Jensen, an ICT expert with consulting experience in 40 African countries, Gabriel Adonalyo, Vice President of the Argentine IXP (NAP CABASE), Roque Gagliano, co-ordinator of the Latin American IXP Association (NAPLA), and Bill Woodcock the Research Director at Packet Clearing House (PCH), a non-profit organization involved in establishing IXPs globally.

The session was highly informative and benefited from a diverse audience of stakeholders from both developed and developing regions, including government, the technical community, civil society, and academia. This report highlights the issues discussed at the session. A transcript from the session is available on the ISOC website at:

<http://www.isoc.org/educpillar/resources/igf-ixp-transcript-2007.pdf>

## 1. Overview

In 1998, the OECD released the report *Internet Traffic Exchange: Developments and Policy*, which among other issues highlighted the role of Internet exchange points (IXPs) in rationalizing Internet traffic flows. Among its contributions to global Internet discussions, the report stimulated interest in the function and development of IXPs from a broad range of stakeholders, including governments and non-governmental organizations.

Courtesy of data provided by Packet Clearing House (PCH), Mr. Paltridge noted that at the time of the meeting, 79 countries around the world had operational IXPs.

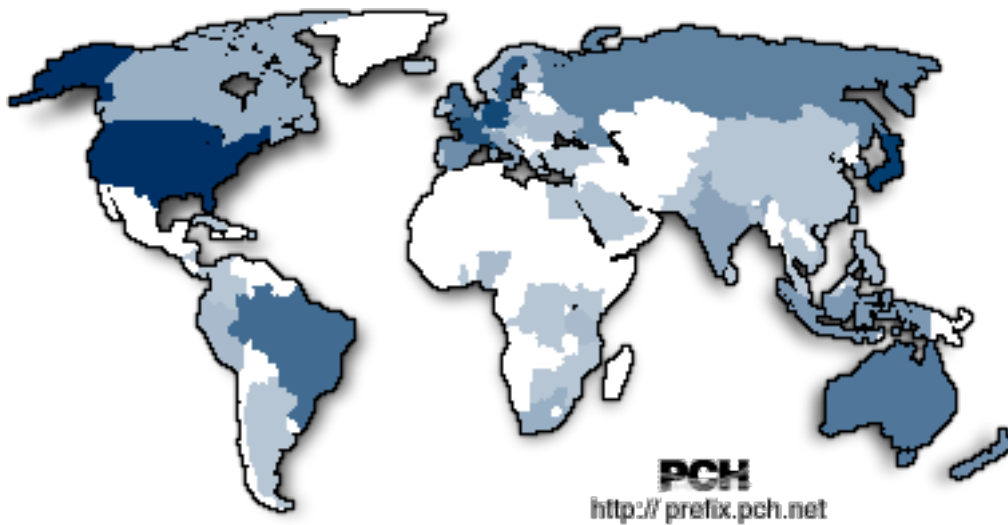


Figure 1: IXP Density Map presented by Sam Paltridge. Data courtesy Bill Woodcock, Packet Clearing House. Current data available at: <https://prefix.pch.net/applications/ixpdir/summary>

## 2. The role of IXPs

The panelists noted that the primary role of an IXP is to keep local traffic local and reduce costs associated with traffic exchange between Internet Service Providers (ISPs). In many developing countries, poor connectivity between ISPs often results in the routing of local traffic over expensive international links simply to reach destinations within the country of origin. In some countries, government regulations require that independently operated ISPs transit their traffic through the incumbent telecommunications operator. Both of these scenarios can place additional costs on ISPs. Mr. Mwangi explained, for example, that prior to the establishment of the Kenyan Internet exchange point (KIXP), ISPs were required to connect through the incumbent operator which bundled transit prices for both local and international traffic. As a result, local traffic was billed to the originating ISP at the same expensive international transit rates.

Furthermore, traffic transiting international links experiences greater latency times, particularly in countries where international connectivity is dependent on satellite links. IXPs can improve the quality of Internet services in a country by reducing the delay associated with packet delivery. In Kenya, for example, implementing KIXP helped reduce latencies from over 700ms to below 100ms. Consequently, users benefited from improved response times, improving their Internet experience.

In addition to providing a more efficient exchange of local traffic, many of the panelists noted that IXPs serve as a convenient hub for hosting value-added and critical infrastructure within a country. KIXP in Kenya and NAP CABASE in Argentina provide excellent examples. Both have implemented local instances of the Internet's F and J root servers in addition to local .com and .net resolution services. As a result, locally originated lookup requests for these services no longer need to transit international links for a response. Value-added infrastructure tools, including network time servers and routing looking glasses have also been implemented at both IXPs. The local presence of these services helps build resilience in the national Internet infrastructure.

Mr. Adonalyo also indicated that the existence of an IXP in a country can encourage the local hosting of content and e-commerce services. He explained that prior to establishment of NAP CABASE, ISPs in Argentina exchanged local traffic in the United States, which contributed to the expatriation of local content and hosting services. The implementation of NAP CABASE, which created an in-country hub for local traffic, has increased the hosting of content in Argentina, including content formerly hosted overseas.

In both the Kenyan and Argentine cases, establishing an IXP was necessary to address the inefficiencies associated with the international switching of local traffic. As a result, the IXPs have improved the quality of service offered to their subscribed users, reduced participating ISPs costs associated with local traffic exchange, and have helped stimulate an environment for the repatriation and local hosting of content and e-commerce services.

### **3. IXP deployment, governance structures, and policies**

#### **3.1 IXP deployment in Latin America and Africa**

The panelists from Africa and Latin America noted that individual ISPs or ISP associations are the predominant drivers of IXP implementation in their local area. Mr. Jensen noted that many ISPs in Africa, in fact, seek to form ISP associations expressly for the purpose of establishing an IXP. Mr. Gagliano pointed to Brazil as a notable exception in Latin America. There, the government-commissioned, multi-stakeholder Brazilian Internet Steering Committee (CGI.Br) initiated the Ponto de Troca de Tráfego Metro project (PTTMetro), aimed at creating IXPs in cities throughout Brazil.

At the time of this panel discussion, IXPs existed in 15 countries in Africa and 12 countries in Latin America.



Figure 2: Internet Exchange Points in Latin America, presented by Roque Gagliano, NAPLA.



Figure 3: Internet Exchange Points in Africa, presented by Michuki Mwangi (data courtesy the Network Start Up Resource Center, [www.nsrc.org](http://www.nsrc.org))

### 3.2 IXP governance structures and issues

In Kenya and Argentina, the IXPs are operated as not-for-profit entities of the ISP association. In both instances, membership in the association is required in order to gain access to the IXP. In Kenya, KIXP does not have a separate governance structure and policies are established through committees of the Kenyan ISP association

(TESPOK). NAP CABASE, however, operates as a separately managed entity of an ISP association (CABASE). Mr. Adonalyo explained that decisions are made through two management committees, one responsible for policy development and project analysis and another focusing on IXP technical operations. Mr. Gagliano noted that IXP management and operational models across Latin America are diverse and that both not-for-profit and for-profit IXPs exist on the continent.

Establishing an IXP in a location and manner considered neutral by its members was identified as important to the success of an association-based IXP. Mr. Mwangi noted that in order to ensure the acceptability of the IXP concept in Kenya, it was essential to emphasize the neutrality of the facility and obtain consent from prospective members on its location. Mr. Adonalyo explained that locating the NAP CABASE infrastructure in the facilities of the ISP association has underscored its neutrality.

Implementing and maintaining carrier-neutral facilities can be a costly venture. Cost elements include power, air-conditioning, security, floor space rental, and staffing, among others. Basic membership fees and port charges are usually levied on IXP participants to offset operational costs. It was noted that surplus revenues, which can result from a growth in IXP membership, are often reinvested in facility enhancements and new services.

### **3.3 IXP policies**

#### **3.3.1 The evolution of IXP membership policies**

The development of sound membership policies and attractive pricing structures are critical to ensuring the success of an IXP. The panelists emphasized that policies and prices need to be reviewed regularly and adjusted to accommodate emerging issues and demands. In Kenya for example, the growth and success of KIXP attracted membership interest from a variety of data generators, such as the local ccTLD, the national revenue collection authority, and multimedia content providers. The previous membership criteria, which required participants to be licensed telecommunications entities, needed to be revised in order to accommodate a wider range of participants. In Argentina, current policies require NAP CABASE participants to be CABASE association members, hold a telecommunication licence, and have an autonomous system number. Mr. Adonalyo explained, however, that NAP CABASE does consider, on a case-by-case basis, applications from participants that do not meet the stated criteria.

In addition to membership fees, IXPs generally charge a per megabit fee for connectivity. The discussion highlighted that peering price structures need to be reviewed regularly in order for the IXP to remain cost effective for its members and competitive over international transit costs. For instance, Mr. Adonalyo explained that the cost of international transit was at one point lower than the costs associated with exchanging traffic locally at the IXP. This led to members de-peering from the exchange, preferring to switch local traffic over international routes. Similarly in Kenya, initial membership fees and peering fees needed to be reduced in order to attract greater participation.

### 3.3.2 Peering policies

The benefits and disadvantages of different IXP peering policies was the subject of much discussion at the meeting and generated many questions from the audience. The peering policies of IXPs globally are diverse, with some encouraging or mandating multilateral peering and others allowing participating data carriers to peer bilaterally. Mr. Mwangi explained that KIXP participants peer on a multilateral basis at the exchange point. He suggested that, particularly for small players in developing markets, a multilateral peering policy can enhance the attractiveness and value of the IXP to the participating community. He further noted that none of the participants in the KIXP have requested the option to peer bilaterally. Mr. Woodcock suggested that mandatory multilateral peering policies may not be successful in more mature markets, as large operators can perceive it as a requirement to enter into an open ended contract with unknown signatories. Mr. Gagliano explained that in Latin America, mandatory multilateral peering has discouraged some large carriers and content providers from connecting to an IXP. The consensus of the panelists gravitated towards encouraging IXPs to adopt flexible peering policies that permit the coexistence of multilateral and bilateral peering arrangements.

## 4. Traffic measurement and IXP documentation

Mr. Mwangi noted that IXPs can provide valuable information on Internet usage patterns within a country by analyzing its traffic. This information can be particularly valuable to participating ISPs, by illuminating potential market opportunities. Mr. Mwangi presented an analysis of KIXP traffic data as an illustration (Figure 4). The data reveals that traffic flows are highest during week day business hours, indicating that ISP services are concentrated on corporate users. Spikes in daily and monthly traffic were also observed and attributed to a rush of users accessing student examination scores published on the Internet in 2007 and a free web-to-SMS product that was offered by a company on Valentine's Day in February, 2007. With this information, Mr. Mwangi highlighted the opportunity for ISPs in Kenya to increase traffic and maximize off-peak capacity by developing products and encouraging content attractive to home Internet users.

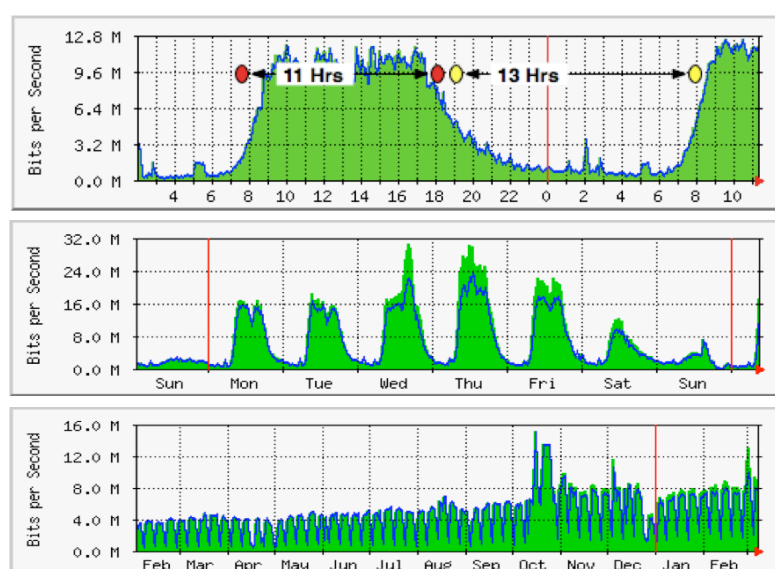


Figure 4: Daily, weekly and annual (2006-2007) KIXP traffic indicating peak and off-peak times, presented by Michuki Mwangi, KIXP



Mr. Woodcock encouraged IXP operators to publish basic data about their operations. The elements he recommended documenting included the number and name of participants at the exchange, the IP addresses held by the participants, and the aggregate traffic flowing through the exchange point. He noted that it would be possible to develop a more comprehensive picture of global Internet traffic with this information and that it would benefit a range of entities including government, industry, and development organizations.

## **5. Government involvement in IXPs**

The panelists at the meeting described various government actions that have influenced the operation and sustainability of exchange points.

Mr. Mwangi explained the Kenyan government shut down the KIXP two weeks after its initial launch in November 2000 on the objection that it infringed on the incumbent telecommunications provider's monopoly licence. After discussions with the regulator, KIXP was permitted to obtain an operating licence and resume operations in February 2002. The licence KIXP received stipulated that only licensed ISPs could participate in the exchange. While an unfortunate delay, Mr. Mwangi noted that the incident opened channels of communication between the ISP community and the Kenyan government. With interest in the exchange growing, the government has permitted KIXP to modify its participation requirements and accommodate data providers that are not formally licensed ISPs. Mr. Gagliano indicated that regulations in some Latin American countries have made it difficult for ISPs or regional operators from one country to connect to an IXP in another.

Mr. Gagliano explained that the Chilean regulator requires all IXPs in the country to be interconnected with one another. As a result, the routes of the ISPs connected to one exchange point are automatically announced to ISPs connecting at other exchanges. While noting that the policy was probably well intentioned, Mr. Woodcock questioned the wisdom of mandating such an approach. He indicated that such a policy could hinder growth by removing the incentives for an ISP to competitively expand its connections beyond a single exchange. Mr. Woodcock also mentioned that a move to implement mandatory interconnection of exchange points in India likely contributed to a lack of growth in the Internet sector over a four year period.

Government agencies have also taken interest in exchange points as a customer of services. In both Kenya and Argentina for example the national revenue collection authorities peer at the exchange points. As noted above, some governments have taken an active role in implementing IXPs as exemplified by the Brazilian PTTMetro project (noted in s.3.1, above).

The panelists also discussed what role, if any, governments should have in IXP licensing and policy management. Mr. Jensen and Mr. Woodcock both indicated that governments should not require IXPs to be licensed nor mandate peering and other policies concerning IXP operations. They were, however, in support of government approaches that play a positive role to encourage ISPs to keep domestic traffic local. Many panelists also noted that government policies aimed at encouraging competitive access to leased lines and wireless connections will help lower the costs associated

with connecting to an IXP. Mr. Adonalyo indicated that governments can also play a positive role by restraining anti-competitive behaviour of incumbents, including attempts by large carriers to block the development of IXPs.

Overall, the panellists agreed that governments, through both beneficial and detrimental actions, can significantly influence the success of an IXP and the efficiency of traffic exchange in their local markets.

## **6. Challenges to the development of IXPs**

A number of challenges to IXP development were described by the panelists. These included:

*Lack of Trust Between Service Providers* – IXPs, particularly not-for-profit association models, rely on their participants to cooperate and coordinate 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. Mr. Jensen noted that a lack of trust between ISPs has discouraged cooperation and hindered the development of ISP associations and IXPs in Africa. Mr. Gagliano indicated that the challenges associated with getting a critical mass of IXP supporters together have inhibited IXP expansion in many Latin American countries.

*Limited Technical Expertise* – The success of an IXP hinges on its ability to route traffic 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. Mr. Jensen noted that the cost of this expertise may actually exceed the cost of paying for international transit, leaving many ISPs to settle for switching traffic through international links. There is need, therefore, to develop a critical mass of local technical skills and expertise, particularly among smaller ISPs and the countries that are yet to establish Internet exchanges.

*Cost of Network Infrastructure* – The absence of reliable and affordable local infrastructure can reduce the incentive and justification for operators to develop and connect to an IXP. In many countries, purchasing a domestic leased line across a city or region to connect to an IXP can be as, or more, expensive than sending traffic through an international link. Mr. Jensen observed that in many developing countries, monopoly pricing and restrictive government regulations on terrestrial and wireless circuits have stifled local traffic exchange and IXP growth.

*Cost of Hosting an IXP in a Neutral Location* – The cost of operating IXP infrastructure in an appropriate, neutral facility can present challenges. In many countries, costs associated with leasing space, ensuring reliable power supply, providing adequate air-conditioning, security, and hiring IXP maintenance staff can outweigh the savings that participants might realize from its operation.

## **7. IXP growth**

Mr. Woodcock explained that the number of IXPs continues to grow globally; however, many developing regions are lagging behind the developed world.

Region	IXPs	Growth
Africa	17	21%
Asia Pacific	67	15%
Europe	107	54%
Latin America	20	94%
North America	87	287%

Table 1: Annualized growth rate of IXPs (as of Nov. 2007).  
Presented by Bill Woodcock, PCH. Current data available at:  
<https://prefix.pch.net/applications/ixpdir/summary/growth-region>

## Summary

The experiences and expert opinions shared at the session underscore the role of exchange points in keeping traffic local, improving the quality of Internet services, providing resilience in domestic infrastructure, and reducing costs. With global growth in Internet data traffic and the digitalization of traditionally analogue services, IXPs are also growing in importance as critical infrastructures. The development of operational practices, management polices, and local infrastructures that ensure their smooth and efficient operation require collaboration among many stakeholders. Governments in particular can play a key role in establishing environments conducive to IXP growth and sustainability.

Overall, there is a need to create awareness about benefits and challenges of establishing IXPs, particularly in the developing world. To achieve this, there is a need to collate more information and data regarding the success of existing IXPs. The information can be used to develop and support the business case for their further growth and establishment.

Further, as more IXPs are deployed in developing countries, there will still be a need to evaluate regionalization of Internet traffic. From the workshop, it is evident that localization of Internet traffic through national IXPs is taking shape; however, the model for keeping traffic within one region is far from fully achieved. Consequently, there is a need to develop more effective regional interconnection models, encourage the deployment of IXPs in areas currently lacking them, and enhance existing IXP operations for greater impact.