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THE BENEFITS OF MAXIMISING LOCAL TRAFFIC via independent Internet exchange points (IXPs) is well-recognised as essential for facilitating a robust domestic Information and Communication Technology (ICT) sector. From a public policy perspective, ensuring the presence of local IXPs has become an increasingly important priority in order to make sure that online services are equally accessible to all local users, as well as to enhance competitive opportunities, and generally improve the quality and affordability of Internet services.

So far IXPs have only emerged in about half the countries in the world, and these vary greatly in scale and effectiveness. To help accelerate the development of new and existing IXPs this Toolkit has been created to describe best practices for setting up and supporting the growth and enhancement of these crucial Internet facilities.

Ideally, IXPs are needed in every region in which different networks need to exchange local traffic. Deployment of IXPs are, however, sensitive to a variety of local constraints, and initiating and ensuring their efficient operation is not as simple as it would appear, especially in emerging markets (where IXPs are rare). Nevertheless IXPs are not a universal solution to a country’s Internet and Internet access challenges. IXPs can and often do complement and improve the functioning of a local Internet ecosystem, but they cannot gloss over problems such as lack of competitively priced international or local capacity, nontransparent regulation, or poor energy supplies.

Research into the experiences of IXPs around the world was compiled for this report and the variety of case studies and data about IXPs presented in Section 6 amply demonstrate that: IP interconnection is still relatively new and there are a wide variety of fees, institutional models, business models,
IXPs are ideally needed in every city where different networks need to exchange local traffic. They are, however, sensitive to a variety of local constraints, and initiating and ensuring their efficient operation is not as simple as it would appear.

Policy rules, and technical strategies adopted by IXPs across the world. Some of the choices made may have constrained growth in interconnection; in other cases, alternative IXPs have emerged to fill needs unmet by the existing IXPs.

As a perusal of the case studies will show, IXPs vary immensely in scale (from a few 100Kbps of traffic to many Tbps), in pricing and in institutional models — from free to use, to nonprofit cost-recovery, to for-profit. There are few geographic trends that can be deduced aside from the commercial/noncommercial divide between the US and the rest of the world; but even this is now blurring with three European IXPs recently launching neutral membership-based services in the United States.

Nevertheless, in broad terms, three main models for operating an IXP have emerged:

1. the for-profit carrier neutral data centre as typified in the United States;
2. the neutral nonprofit member-owned organisation operating on a cost recovery basis, with infrastructure often hosted at a commercial data centre; and
3. the sponsored IXP, supported either by a ccTLD manager, a regulator, an NREN, or a large network operator.

In the last two years, there has been a notable surge in the number of IXPs in secondary cities, particularly in Argentina, Brazil and Indonesia, but also in secondary cities around the world, including Arusha, Adelaide, Buffalo, Cork, Durban, Edinburgh, Grenoble, Leeds, Lyon, Manchester, Manitoba, Mombasa, Port Harcourt, Saint Etienne, Toulouse, Turin, Winnipeg, and Zurich.

This trend reflects increasing local content consumption, decentralisation of content redistribution, and overall growth in bandwidth demand built on the steady extension of high bandwidth cable and wireless networks. While most of this growth has so far been in more developed economies, the same trends are becoming evident in emerging economies.

In addition, aggregating outbound traffic and avoiding tromboning is likely to be more critical in smaller secondary city markets where local ISPs typically face higher transit costs and longer routes to the desired content.

At the same time, the scale, reliability, and geographic scope of existing IXPs is growing. Many IXPs now offer multiple sites, remote peering, and ‘partnership programmes,’ often called service-provider or reseller plans. Such programmes leverage the benefits of the remote peering model and low cost national or regional backhaul, minimising technical support needs for the IXP and taking advantage of link aggregation.

Regional extension of networks is also being encouraged in countries where the IXP may operate its own links to a neighbouring city or country. In France, members of France-IX may freely use up to 100Mbps of connectivity between Paris and Lyon, Toulouse, Luxembourg, and Italy, after which they need to purchase their own links.

Global expansion of IXP presence is also a noteworthy recent trend. For example, Dutch IXP AMS-IX now operates an IXP in Curacao and Hong Kong, and is collaborating with KIXP to manage the Mombasa exchange in Kenya, while DE-CIX operates the UAE-IX, the Dubai exchange and DE-CIX New York. While increasing economies of scale and attracting new members are some of the motivations for this, demand for the skills and expertise developed at leading exchanges is another.

MANY IXPS HOST REGULAR SOCIAL, TECHNICAL, OR INDUSTRY EVENTS TO HELP BUILD THE LOCAL COMMUNITY OF PEOPLE INVOLVED IN PEERING.

Another feature of many IXPs is the presence of domain-name server mirrors for a variety of gTLDs and ccTLDs. However, surprisingly few IXPs offer a wider variety of shared services such as time servers, CERT, and software mirrors.

It is also noteworthy that policies that promote multilateral peering are present among a significant number of IXPs on either mandatory terms or incentivised through discounts on the port fee for the invited party. The majority of IXPs, however, also offer bilateral peering and VLAN services and of late, a few are beginning to offer VoIP or GRX type services.

Many IXPs also host regular social, technical, or industry events to help build the local community of people involved in peering and add another membership benefit. Twinning programmes (programmes in which experienced IXPs partner with developing IXPs) to support emerging IXPs have also
been adopted by some of the larger exchanges such as those in London, Amsterdam, and Stockholm. Some IXPs also have created positions for policy staff in order to inform and educate local and global policymakers.

A significant number of IXPs are still operated without charge; however, the majority of IXPs have pricing for participation ranging from simple joining free to charges almost equalling the cost of transit. We have seen that there is great variability in fees, especially for smaller emerging country IXPs, many of which may have donated space and equipment, and so are able to minimise fees to attract members before moving on to achieving a cost recovery position.

A significant number of IXPs are still operated without charge; however, the majority of IXPs have pricing for participation ranging from simple joining free to charges almost equalling the cost of transit.

The most important variable in IXP pricing is port speed. This may need to be balanced against membership fees (if any) or setup fees (if any) as well as the backhaul costs of getting to the IXP and the availability of link aggregation and discounts for second ports to allow smoothing the costs as network needs grow (for example, a network needing 1.2Gbps could cost the same as 2x1Gbps ports or 1x10Gbps port without link aggregation).

In analysing the current costs for use of IXP services, 1Gbps and 10 Gbps ports are the most commonly available. A minority of IXPs have 100Gbps services and below 1Gbps, ports may not be available or may even be free. (See page 27, figure 4.6, for the annualised port cost for 1 and 10Gbps ports at a variety of IXPs in different locations around the world.) There is greater variability and inconsistency in charges for 10Gbps ports.

The case studies and data samples provided in this report draw on information from a variety of sources, including the IXP websites, national ICT market profiles, and personal interviews for this study with IXP managers. In the course of gathering this data, researchers found little consistency in the presentation of basic information on IXP websites. Few IXP websites in emerging markets provide the three main data points: pricing, membership policies, and peers lists. Traffic statistics are also missing from many sites while some may show disaggregated data with the traffic history of each network connected to the exchange. In other cases, information may be buried in a hard to find web link or may not be current. Overall, only a small minority of IXPs operate websites that fulfil the basic requirements of a prospective peer for up-to-date, easily accessible information.

Further case study information and additional materials can be found on the IXP Toolkit portal at http://www.IXPToolkit.org.

* Note about releasing this “Collaboration Draft” of the Toolkit and Portal. We plan to enhance and amplify many areas of the Toolkit in April, when we release v.1.0 of the Toolkit. Thus, the release of the IXP Toolkit & Best Practices Guide, now, as a “Collaboration Draft.” More input from the community is essential. The Toolkit Portal (www.ixptoolkit.org) is meant to be a more detailed resource, and we also are asking for continuous feedback and information from the community. Feedback about the Toolkit and Portal can be sent to feedback@ixptoolkit.org.
This document was developed by a long list of individuals and from consultations with many experts. We will cite proper acknowledgments upon release of v.1.0 in late April. For now, we offer a preliminary “thank you” to everyone we have spoken with, worked with, and may come back to for more data.
An Internet Exchange Point (IXP) is simply a physical location where different IP networks meet to exchange traffic with each other with copper or fibre cables interconnecting their equipment, usually via one or more Ethernet switches. They keep local traffic local.

The benefits of access to these local traffic exchange facilities are many, and are described in detail further below. IXPs are now well recognised as a vital part of the Internet ecosystem, essential for facilitating a robust domestic ICT sector. From a public policy perspective, ensuring the presence of local IXPs has become an increasingly important priority in order to make sure that online services are equally accessible to all local users, as well as to enhance competitive opportunities, and generally improve the quality and affordability of Internet services.

Nevertheless IXPs are only present in about half of the world’s countries, and even where they are present, many are not functioning to their full potential. Most cities could benefit from the presence of an IXP, but even large, highly industrial

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1 See for example, the OECD’s recent report on Internet Traffic Exchange: http://www.oecd-ilibrary.org/science-and-technology/internet-traffic-exchange_5k918qpt130q-en
2 https://prefix.pch.net/applications(ixpdir/summary/
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countries such as Canada only have a handful of IXPs. It turns out that IXPs are actually quite sensitive to a variety of local constraints. Initiating them and ensuring their efficient operation is not as simple as it would appear based on their evident benefits, especially in emerging markets (where IXPs are rare).

However IXPs are not a universal solution to Internet challenges in a country. They can complement and improve the functioning of other parts of the Internet ecosystem such as by providing a more competitive environment for purchasing capacity and offloading traffic from congested international links, but they cannot address problems such as lack of competitively priced international or local capacity, non-transparent regulation, or poor energy supplies. For further details on such issues, see the Internet Society report entitled Lifting Barriers to Internet Development in Africa. To help accelerate the development of IXPs this Toolkit has been created to describe best practices for setting up an IXP and supporting the growth and enhancement of existing IXPs.

To improve understanding of IXP dynamics, the Toolkit aims to address the following key themes and issues:

- How IXPs make countries and regions more economically and technically autonomous, including the role IXPs play in improving regional interconnection, fostering development of local content and culture and improving information security.
- The role of IXPs as ‘nerve centres’ of the networks that comprise the Internet that help accelerate the spread of Internet services, and improve access to critical Internet resources.
- Learning from well-established IXPs in both developed and developing countries with a view to localising, and replicating the most effective strategies for IXP development in other, often smaller and less developed countries and cities.
- Identification and explanation of the policy and regulatory environment needed to ensure the viability and efficient functioning of IXPs. This includes analysis of the role played by the main stakeholders – the Internet industry, government, civil society and the public.

A key part of the Toolkit is a methodology that is intended to assist in guiding strategy for establishing new IXPs and benchmarking the progress of existing IXPs. A key aspect is to identify constraints that IXPs commonly face in growing. In this respect the Internet Society hopes that others will join in the process of improving the Toolkit and that the document will generate debate about how IXPs can best reach the next ‘level’ in order to fully benefit from the impact of maximal interconnection.

The Toolkit makes extensive use of case studies and IXP data that provide an illustrative survey of different types of IXPs from around the world. These case studies and basic data are presented at the end of the document. Development of the Toolkit has taken place in consultation with IXP experts, network operators, and other relevant practitioners who were provided with early drafts for review and comment. The intention is that this will be a living, iteratively refined document and that reader comments will be used to refine it.

The benchmarking methodology developed and outlined in detail in the document is to be tested with twelve selected IXP initiatives. Wider testing will take place if other IXPs choose to participate in the online self-assessment opportunity. We welcome comments and feedback on the IXP Toolkit, the methodology found in this Toolkit, and the IXP Toolkit Portal (www.ixptoolkit.org). Send your feedback and comments to feedback@ixptoolkit.org.

The Toolkit is aimed at all parties interested in IXPs (ICT market regulators, network operators, IXP managers, and content providers) and is designed for those who may not have deep technical knowledge of the intricacies of Internet traffic exchange.

Examples of specific products and services mentioned in this document do not imply endorsement by the Internet Society or the authors of the Toolkit.