4. The Economics of IXPs

The general benefits of the presence of IXPs have been described earlier in the Toolkit, however the economic incentive for network operators is often the most tangible benefit, and thus usually the initial motivation to join an IXP, or to assist in their establishment where there are none. Documenting the cost savings that can be achieved by exchanging local IP traffic within the country is often vital for making the argument to network operator decision-makers to make the investments needed to join or help set up the IXP.

Joining an IXP will be attractive if the cost of exchanging traffic locally is cheaper than purchasing international bandwidth (IP transit) from an upstream provider for routing the traffic overseas. Given that international bandwidth can comprise a significant portion of operating expenses for ISPs in developing nations, an IXP can significantly reduce costs, resulting in lower Internet access subscription charges for users, provision of more bandwidth and making the costs saved available for increased network build-out.

The financial attractiveness of an IXP is influenced by several factors such as market structure and the volume of local traffic. Due to market structure, a significant amount of traffic may stay within an ISP’s network (i.e., “on-net” traffic). In this case, typical of environments where only a few ISPs dominate the market, there may be little incentive to participate in an IXP. Another situation would be where most Internet traffic is destined to users or websites overseas. An IXP would be unlikely to ameliorate the necessity for international IP

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1 Historically developing nations have had to pay for the full cost of the circuit to overseas PoPs and addressing this has long been part of the Internet governance agenda.
transit, at least in the short run. It could be argued that these situations are characteristic of domestic market weaknesses, and untreated, are likely to impact the long-run sustainability of national Internet ecosystems. A healthy and competitive Internet market is critical for affordability and innovation. The Internet market will never be deep rooted until there is significant local content available. The establishment of an IXP can therefore be a trigger to financial viability for smaller or new ISPs, resulting in greater market competition and stimulation of local content development.

Whether an IXP makes financial sense for ISPs can be analyzed by comparing the cost of IP transit to the cost of domestic peering. An example based on actual 2010 values for the German Internet Exchange (DE-CIX) illustrates this calculation. It is based on the assumption that all traffic is destined for local termination although in reality this is rarely the case. The cost of peering is calculated based on three distances to DE-CIX: local, nearby and far. The cost of IP transit has been estimated at US$3.50 per Mbps based on interviews with several ISPs. Peering costs include the variable transport charges to the IXP depending on location as well as the common costs for a 10G port in the IXP, colocation fees and router amortization (figure 4.1).

Table 4.1 shows the level of traffic required for the IXP to be a cheaper alternative than IP transit (“break-even point”) for the various scenarios based on the IP transit cost of US$3.50 per Mbps. The break-even point is dependent on the volume of traffic and the ratio of local vs. international traffic. Given the higher transport costs for ISPs that are further away, they also require a higher level of traffic to break-even.

Note that some national fibre backbones and submarine links have relatively distance-independent pricing, which can affect this part of the calculation. In addition, the local peering/IXP fees may be much lower in a developing-country context (for example, in Ecuador, the cost is about US$1/Mbps/month). Table 4.1 also shows the minimum cost of using the IXP on the assumption that 70% of the 10G port will be utilized.

The key factor influencing the decision to peer in this example is the volume of traffic. As the volume increases, the per-unit cost of peering decreases. If the ISP has sufficient traffic, then peering will be a less expensive option than IP transit. Figure 4.2 (following page) illustrates this, showing the different break-even points depending on the distance from the IXP.

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2 A simple spreadsheet or web application could easily be created to allow IXPs or prospective IXP founders to make the calculations of savings based on local conditions — all that would be needed is the cost of domestic and international capacity, number of links, and volume of traffic. Revenue angles that IXPs should consider will be included in the next iteration of this report.


4 INEX is the Internet Neutral exchange located in Dublin, Ireland, www.inex.net. INEX developed and collaborates with IXPs around the world to improve its free software, IXP Manager, which enables IXPs to keep track of data, manage IXP members, and provide more services to members. See the presentation by Nick Hilliard, INEX CTO, at http://www.internetsociety.org/events/serbian-open-exchange-%E2%80%93-ixp-workshop.
A quick rule of thumb for determining the break-even traffic point is dividing the monthly cost of connecting to the IXP by IP transit costs (per month per Mbps). In many developing regions, the cost of IP transit remains high so the amount of traffic required to make an IXP financially attractive is normally low. The key price breaker is the connectivity cost to get the ISP’s traffic to and from the IXP. These domestic transport costs can often exceed the pure peering costs (port and colocation charges), particularly as the distance to the IXP increases.

In the following list, the economy-wide impact of the savings from domestic peering has been quantified for four developing countries. Note that the savings reflect the estimated cost of IP transit if current IXP traffic had to be routed overseas. (Kende and Jurpy 2012, Galperin 2013)

**Argentina (2013)**
**Savings: US$12.3 million**
The wholesale cost savings associated with local traffic exchange at the new IXPs can be estimated as follows. Before the establishment of IXPs in other cities, NAP Buenos Aires was exchanging around 2Gbps during peak traffic. Today traffic peaks are as high as 12Gbps. Assuming this additional 10Gbps of traffic was previously exchanged between local operators over transit agreements, and assuming a very conservative transit cost estimate of US$100 per Mbps per month, the new IXPs are generating wholesale savings of US$12.3 million per year. Even discounting transport costs to the IXP (which as explained below aggregate traffic from large geographical areas), IXP fees and related equipment costs, the savings are very significant, and tend to be higher for operators in less developed markets.

**Ecuador (2013)**
**Savings: US$7.2 million**
NAP.EC currently exchanges about 6Gbps during peak traffic. International transit costs in Ecuador hover around US$100 per Mbps per month. By contrast, local traffic can be exchanged at NAP.EC for as little as US$1 per Mbps per month. Assuming that in the absence of NAP.EC operators would exchange local traffic through international transit routes (i.e., assuming no bilateral peering agreements), the additional wholesale costs for local ISPs would be US$7.2 million per year.

**Kenya (2012)**
**Savings: US$1.4 million**
ISPs credited all of their local traffic exchange to the impact of KIXP – stating that without the KIXP all of their traffic would trombone. This means that without the IXP, the entire current 1Gbit/s peak traffic exchanged through the IXP would be carried over international transit connections. In terms of the cost of those circuits, there are a wide variety of values ranging from US$90–250 per Mbit/s of traffic per month for wholesale service. The differences in values reflect a number of variables, including traffic volume, use of self-owned capacity, and routing; one source suggested an average value of US$120 per Mbit/s for international transit. Using that relatively conservative value, the wholesale savings of exchanging 1Gbit/s at KIXP instead of using international transit to trombone the traffic is US$1,440,000 per year.

**Nigeria (2012)**
**Savings: US$1.1 million**
ISPs today are typically paying in the range of US$250–400 per Mbit/s of traffic/month for international transit (the differences in values for wholesale services reflect a number of differences between buyers such as traffic volume, route, and use of self-owned capacity). Using an average cost of US$300 per Mbit/s for international connectivity, the wholesale savings of exchanging 300Mbit/s at IXPN instead of using international transit to trombone the traffic is US$1,080,000 per year.

In addition to the quantifiable financial benefit, IXPs increase competition in the market by providing another option for exchanging traffic. This should put downward pressure on IP transit prices. Another distinguishing feature of IXPs compared to IP transit, is that the former are much more transparent by generally publishing their connectivity pricing and traffic levels.

Given that the financial benefits of an IXP include saving expenditure and providing a competitive alternative to IP transit, it may seem surprising that there are still more than 100 countries without one. Reasons include a lack of cooperation among domestic ISPs, policy and regulatory issues, as well as market structure. In the latter case, some ISPs dominate the market, accounting for a significant portion of domestic IP traffic that they may exchange within their own
network (i.e., “on-net”). Larger ISPs often have their own IP backbone arrangements, generally through participation in a global telecommunication group.

Such ISPs do not see a financial gain from open peering at an IXP since they would likely be receiving much more traffic than they send. Take the case of Mexico, which at the end of 2013, was the largest country (and only OECD member) without an IXP. It has significantly higher IP transit costs than other OECD countries, all of which do have IXPs (figure 4.3). One reason cited for Mexico’s lack of an IXP is resistance by the incumbent telecommunication operator that already generates significant on-net traffic and wants domestic ISPs to use its IP transit services.  

Despite the competitive impact on IP pricing and potential for lowering Internet access prices for consumers, it is somewhat surprising that many countries are not more supportive of IXPs. This is even more puzzling considering international consensus encouraging IXPs.

Governments can foster an enabling environment for IXPs through various steps, such as supporting community-based IXP development; nurturing consensus-building among industry stakeholders; promoting local content; lowering or eliminating taxes for computer hardware and software; stimulating competition in national and international IP transit markets and other pro-Internet policies. A light handed regulatory approach is favored so as not to affect incentives to expand the market.

Community-based IXP development as noted has been an extremely successful IXP model. Bringing stakeholders together is no easy matter in some countries and regions, but the importance of community-building to create a sustainable environment can not be underestimated. It may take years to build both trust among competitors and a sustaining environment, but this process is integral. From Ecuador to Malawi this process has led to the development of an IXP, and created a strong community of practice around the IXP and in the technical community.

**IXP Finances**

Although IXPs share the basic function of exchanging traffic among members, they vary widely in business models, operations, scope, and size. A key difference is market orientation in terms of private versus cooperative ownership and the setting of prices for price maximization versus cost recovery.

Another difference is that IXPs vary tremendously in size, a function of the level of Internet market maturity as well as geography and population (figure 4.4, following page). These factors influence the range of services provided, operational performance, and pricing that impact IXP finances.

Regardless of the institutional set-up, even nonprofit-oriented IXPs need to recoup costs to achieve sustainability. Therefore revenues need to be sufficient to cover expenses plus an allowance for reinvestment. In deciding how to price services, IXPs need to ensure that they are a competitive alternative to IP transit, bearing in mind the transport costs ISPs incur.

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6. For example, the 2013 International Telecommunication Union’s (ITU’s) World Telecommunication and Information and Communication Technology Policy Forum adopted “Opinion 1 on Promoting Internet Exchange Points (IXPs)” as a long-term solution to advance connectivity.” See [https://itu.news.itu.int/En/4140-Promoting-Internet-exchange-points-to-advance-connectivity.note.aspx](https://itu.news.itu.int/En/4140-Promoting-Internet-exchange-points-to-advance-connectivity.note.aspx).


8. In our next iteration, we plan to highlight the key roles individuals have played in starting IXPs. In some countries, the volunteer efforts of one or two people and/or the support of technical experts from the network operator group community and national research and education community have catalyzed the development of the IXP and IXP community of practice.
to connect to the exchange. Otherwise, peering at the IXP will not be financially attractive for ISPs.\(^9\) For this reason it is crucial for IXP sustainability that there is a competitive market in national capacity to reach the exchange.

IXPs earn income through a variety of fixed and variable charges. Fixed charges can include membership fees; port charges (also known as usage charges) are variable. Some also earn revenues from charging for colocation, operating a CERT, or providing other services.

Some ccTLD registrars support IXPs through the significant source of revenue derived from domain name registrations. For example the National Internet Exchange of India earned two thirds of its revenue from registrations for the .IN TLD in its fiscal year ending March 2010 (NIXI 2010).

Many IXPs recoup a significant portion of their costs via usage charges (by specifically charging for a port of a specific capacity at the exchange) and via membership fees. While we are not suggesting that this is a common practice among IXPs, following are additional policies specific to port charges on which we were able to find data:

- In India, in addition to port charges, there are also traffic payments with the National Internet Exchange of India (NIXI) settling the amounts between ISPs based on net traffic flows. Content providers (i.e., having outgoing traffic more than five times incoming traffic) are charged proportionally more.\(^10\)
- At the Hong Kong Internet Exchange (HKIX) there are no port charges and instead participants provide their own equipment.\(^11\)
- In addition to port charges, the Malaysian Internet Exchange (MyIX) also charges for the volume of traffic.\(^12\)
- The Internet Service Providers’ Association (ISPA) of South Africa exchanges (CINX, DINX, and JINX) have different port charges for members and nonmembers. In addition, members must be of the Large category to lease 1Gbps or 10Gbps ports and at least in the Medium category to lease a 100 Mbps port. The categories are determined by fees paid. Nonmembers are not allowed to lease 10Mbps ports (table 4.2).\(^13\)

There are several port capacities on offer at IXPs around the world. Smaller IXPs offer capacities as low as 10Mbps whereas some of the larger IXPs are starting to provide 100Gbps ports. Knowing what port sizes to offer requires the IXP to monitor usage, particularly when members are leasing multiple ports due to the lack of higher capacity ports. This must be balanced against the requirements of members that could be disadvantaged if small port capacities are not available. One way of matching capacity to ISPs needs is to allow members to resell extra capacity. Also of note here is that some IXPs offer port aggregation and/or fractional port charges to smooth the upgrade costs from one speed to the next.

**IT IS CRUCIAL FOR IXP SUSTAINABILITY THAT THERE IS A COMPETITIVE MARKET IN NATIONAL CAPACITY TO REACH THE EXCHANGE.**

The lease price logically increases with the size of the port but on a per bit basis, the larger ports are significantly less expensive. For example a 100Gbps port on the Amsterdam Internet Exchange costs 10 times more than a 1Gbps port, e.g., the monthly per Gbps charge of a 100Gbps port is US$64, compared to US$643 for the 1Gbps port (figure 4.5, following page). Therefore scale is critical since marginal costs come down significantly with each increase in port size.

There is a large variation in port charges among IXPs. A review of 1Gbps port charges shows that the least expensive offer differs from the most expensive by a factor of over four (figure 4.6, following page), not taking into account IXPs that do not charge for ports, but earn income in other ways. The

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\(^9\) In Kenya, the revenues outweighed the cost savings 4:1. Connecting to the exchange was more cost effective compared to the cost of joining and connecting to the exchange.

\(^10\) http://nixi.in/en/routing-and-tariff-policy

\(^11\) http://www.hkiz.net/hkix/policies.htm

\(^12\) See “MyIX Subscription Form” at http://myix.my/services/

\(^13\) http://ispa.org.za/ix/ixx-policy/
variation is even greater among 10Gbps port offers where the price magnitude between the least and most expensive is eight. Port charges can vary due to the price of equipment in the national market, the quality of the equipment, taxes and labor costs. There may be 'off-list' prices negotiated with larger networks to encourage them to join. Optional membership fees also influence port charges (e.g., in the case of South Africa, nonmembers of the IXP pay significantly more than members).

The volume of an IXP's traffic does not seem to have significant influence on the price. The Amsterdam exchange has by far the highest traffic among the IXPs studied yet port pricing falls into the middle range. The average price for a 1Gbps port was US$6,921 per year and US$18,763 for a 10Gbps port among the IXPs studied.

An IXP must pay careful attention to operating expenses to reduce costs for members and ensure that it remains a viable alternative to IP transit. Personnel, energy and premises form a significant proportion of operating expenses for IXPs. Many IXPs may be able to obtain premises at low cost or free, such as via a university, government office (the regulator), or a data centre that sees value in an IXP for attracting other tenants.

Some of these costs can be mitigated through the cooperative nature of many IXPs. For example members could defray some personnel costs by carrying out some activities and there may be scope for bringing in interns willing to work for less or free in exchange for the experience. Similarly some IXPs can lower their building rental by locating in data centres that see their presence as an attraction for other customers.

A further example of how member-led IXPs can help reduce costs is through cross-connect pricing. These are the charges to provide fibre-based connectivity between peering equipment in the exchange. The cost of cross connects are significantly lower in Europe where the model of cooperative IXPs is prevalent compared to North America (figure 4.7, following page), where for-profit companies typically provide exchange services, and in some markets there are "veritable monopolies."\(^{14}\)

Some IXPs have noted that the difference in cross-connect pricing is a function of the competition in the colocation market in a specific city.

Depreciation is also a significant expense item. Given the technological nature of IXPs, it is critical to ensure that sufficient funds are set aside for reinvestment in hardware, software and services. Estimates of the capital expenditure

for launching an IXP vary, particularly as organizations like Cisco, the Internet Society, the Network Startup Resource Center (NSRC), and PCH can provide donated equipment at startup and as an IXP “levels-up.” One source estimates the investment for starting an IXP at between US$40,000–100,000, an amount that could be recouped fairly quickly provided there is sufficient traffic (Woodcock and Edelman 2012).

Few IXPs publish traditional annual reports containing income statements, balance sheets and other financial and operational information—in carrying out the research for this report only three could be found (AMS-IX, Czech IXP, and NIXI (the last being somewhat dated (2010))). Given that few IXPs formally disclose financial and operational data, it is difficult to analyze revenues, cost recovery, and investment strategies for the overall industry. Tracking and making operational and financial metrics publicly available would benefit the global IXP community by providing data for comparable industry benchmarking.

**IXPs and the National Internet Ecosystem**

As IXPs expand, they trigger a virtuous circle for national Internet ecosystems (figure 4.8). By keeping domestic IP traffic local, IXPs enhance performance. This in turn makes content, services and applications more attractive to use, growing the Internet market. In addition, prices are lowered since costly IP transit is avoided, saving money for consumers and increasing Internet penetration. The growth in Internet use, coupled with faster access to local websites, attracts content providers. They benefit from better response times to their services, which generates additional income. Growing traffic at the IXP spurs investment in national backbone infrastructure in order to connect other parts of the country to traffic exchange services. These factors, coupled with important human capacity gains as technical skills become enhanced, contribute to the sustainability and expertise of the IXP, allowing it to offer additional services and assume an important public policy role for the industry.

**Internet Use**

The speed and latency requirements for various cloud-based Internet services can be classified into basic, intermediate and advanced (table 4.3, following page). In order to use the most advanced services, a latency of less than 100 milliseconds (Ms) is required. This requirement provides an important impetus for the creation of IXPs. By keeping local traffic local, they dramatically reduce latency.

High latency impacts the Internet user experience. Telecom equipment manufacturer Nokia estimates that latency is more important than access speeds for applications such as VoIP, music downloading and gaming (NSN 2009). Users are becoming more sensitive to latency and will stop using applications that take too long to load. On the other hand, when applications load quickly, they are more attractive and drive demand and increase penetration.

Routing IP packets overseas via long-haul traffic routes implicitly doubles latency since a round-trip is required. With an IXP, traffic does not have to travel abroad and then return. As a result users can enjoy applications that they would not have been able to use before because latency was too high. This should help to drive higher Internet take-up. The reduction in latency from the establishment of an IXP has been

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15 This refers to neutral multilateral peering IXPs. There are private companies that provide IXP like services but more commonly provide hosting type services for participants to interconnect.
THE ECONOMICS OF IXPS

documented in a number of studies. For example, the creation of the Kenyan Internet Exchange Point (KIXP) reduced latency from 200–600Ms to 2–20 (Kende and Hurpy 2012).

In addition, since IP transit is avoided for domestic traffic, the cost of supplying Internet access is reduced. As a result ISPs can offer cheaper Internet access packages to consumers. Some ISPs charge lower prices or offer higher or no caps on user Internet charges for domestic traffic. The lower prices help to stimulate demand for the Internet and increase penetration.

Growing local traffic also increases revenue for ISPs. In Kenya, ISPs offering mobile data services saw their traffic increase by at least 100Mbit/s due to the presence of the IXP. This triggered an estimated US$6 million increase in revenue, as the ISPs charge by the MB for data (Kende and Hurpy 2012).

Content

The improved latency provided by the IXP coupled with the growth in Internet use and neutral peering attracts other players to join. They include domestic companies, government, the educational sector, the banking sector, international content providers and Content Data Networks (CDNs).

As we noted earlier in this report, lower latency helps to foster the development of domestic content and services. National websites that had previously been hosted abroad will find it more attractive to connect to the IXP if most of their customers are local. In Colombia, although adequate international bandwidth to the United States results in latency of about 45ms, for local traffic it is only 3Ms, providing a strong justification for hosting content in the country (Galperin 2013). Not only will access to domestic sites improve, but local companies also can save on overseas hosting and transit charges. Thru Vision, a Malaysian web development company is hosted in the same datacenter with the Malaysia Internet Exchange (MyIX) and notes the benefit to local websites of the extra redundancy of having multiple ISPs in the same facility. In Malawi, local banks have begun discussions with the IXP as the IXP can provide a more stable and reliable environment.

Hosting a country’s top level domain (ccTLD) and generic top level domain (gTLD) root servers at the IXP enhances quality through faster domain name resolution and increases resiliency for websites using those domains. The root server for Kenya’s ccTLD (.ke) is connected to the Kenyan Internet.

16 In South Africa, Telkom does not have a data cap for its ADSL packages when accessing servers hosted in the country. http://residential.telkom.co.za/broadband-internet/broadband_services/adsl/cost_dsl_cost.html


Table 4.3. Levels of Cloud Sophistication and Related Quality of Service Requirements. Note that concurrent and multiples instances of applications will require faster a network. (Source: Adapted from http://www.cisco.com/en/US/netsol/ns1208/networking_solutions_sub_sub_solution.html)
The improved quality of service and growing Internet market is appealing to international content and service providers. Revenues from the service offerings of large Internet companies such as Amazon, Google and Microsoft are particularly sensitive to response times (NSN 2009), giving them an incentive to take advantage of reduced latency. Google’s Global Cache (GGC) program places servers in IXPs to improve performance and typically can handle between 70–90% of its traffic. Experiences from Latin America demonstrate the impact from GGC. In Ecuador, the installation of GGC at the IXP increased the importance of peering for other networks. Latency for local content is reported at about 20Ms, compared to 150Ms for content located abroad (Galperin 2013). In Argentina, Google is estimated to account for over half the country’s Internet traffic. Since GGC was installed at the Cabase Buenos Aires NAP in October 2011, latency to YouTube and other Google properties is estimated to have dropped by a factor of ten (Galperin 2013). Similarly traffic has exploded in Kenya and Nigeria following the introduction of Google caches at KIXP and IXPN. After the installation in 2011, Google traffic soared making up around half the IXP traffic in both countries (figure 4.9).

Similar to content providers, CDNs also benefit from the open peering and improved performance available at the IXP. Akamai, one of the world’s largest providers of web-based third party content joined France-IX to reach a large number of ISPs through a single connection and to avail itself of better optimization. Since joining in 2010, Akamai has quadrupled its port capacity to 40Gbps, the largest on the exchange along with Numericable, a fibre optic Internet access and streaming video provider. Other companies with large port capacities on France-IX include multinational cloud services companies such as Amazon, Facebook, and Google. In Malaysia, Amazon, Facebook and Microsoft joined the country’s Internet exchange (MyIX) in 2013 to reduce latency for users and lower international connectivity costs. The growing number of “eyeballs” (an Internet marketing term referring to people who look at web pages) in Malaysia, fueled by exploding access, IXPs play a critical role in enabling online public services. Given that most e-government users are resident in the country, it is logical to locally host servers and exchange data within the country and subject to national privacy laws (Woodcock and Edelman 2012) and availability is enhanced with immunity.

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19 https://peering.google.com/about/ggc.html

20 https://www.franceix.net/fr/members-resellers/members/

to disruptions on international circuits. The Kenya Revenue Authority (KRA), responsible for collecting the nation’s taxes, has benefitted by connecting to KIXP. Income tax forms and trade documents can be filed online with significant increases in data traffic as deadlines approach (Mwangi 2012). Savings to the private sector from having access to KRA online services has been estimated at US$45 million.²³

Infrastructure

The growth of the IXP reduces traffic exchange costs, lowers latency, enhances redundancy, and attracts domestic and global content providers. This increases the appeal of connecting other parts of the country to the exchange. Building out domestic networks increases a country’s infrastructure assets, reduces access costs for users and shrinks digital gaps within the nation.

There are different strategies for connecting regional ISPs to IXPs. One is for the IXP to increase its geographic reach by establishing additional nodes in other locations. A second strategy is to build out domestic backbone connectivity so that different parts of the country can reach the IXP. In practice, both approaches are often followed since it may not be feasible to put an IXP node in every location.

A number of countries, particularly of large geographic size, have created additional IXP points of presence, referred to by some as virtual IXPs. For example, NIXI, the Internet Exchange of India has seven locations, PTT of Brazil has 24 locations, while the Moscow Internet Exchange (MSK-IX) is interconnected to eleven sites in the capital as well as eight other Russian cities (figure 4.10).

In countries where there is only one physical IXP, ISPs located in other areas would need to obtain a backhaul link in order to connect. The high cost or lack of high-speed national backbone connectivity has been a deterrent to connecting ISPs to the IXP. In some cases the cost of domestic connectivity is higher than international IP transit (particularly when charged on a distance rather than traffic basis). For example, it is cheaper to send traffic via submarine cable from Capetown to Johannesburg versus sending traffic completely overland via terrestrial fibre. This also is an issue where there are multiple IXP nodes since they will not reach every population center.

THE GROWTH OF THE IXP REDUCES TRAFFIC EXCHANGE COSTS, LOWERS LATENCY, ENHANCES REDUNDANCY, AND ATTRACTS DOMESTIC AND GLOBAL CONTENT PROVIDERS. THIS INCREASES THE APPEAL OF CONNECTING OTHER PARTS OF THE COUNTRY TO THE EXCHANGE.

Given the benefits of connecting to the IXP, countries are encouraging the deployment of national telecommunications infrastructure through a variety of strategies. In some cases, governments are promoting domestic backbone connectivity using a variety of policies. This includes developing national fibre networks through public private partnerships. The latter is an option where the costs of construction are too high and the private sector is not convinced of the return on investment. Another strategy for encouraging fibre deployment is through regulatory tools such as price controls on operators with significant market power in the domestic wholesale bandwidth market or encouraging infrastructure sharing among operators. One of the simplest solutions is simply to allow a competitive wholesale bandwidth market. This will attract domestic and foreign investors as well as utilities such as power companies and railroads with their own fibre optic networks.

Kenya has pursued a number of these strategies. The government has funded the National Optic Fibre Backbone Infrastructure (NOFBI) network extending thousands of

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THE GROWTH IN DOMESTIC IP TRAFFIC CAN ATTRACT INTERNATIONAL BANDWIDTH PROVIDERS, AND CAN BE PARTICULARLY IMPORTANT FOR LANDLOCKED COUNTRIES. ONE OPTION FOR A LANDLOCKED COUNTRY IS FOR INTERNATIONAL IP-TRANSIT PROVIDERS TO ESTABLISH A POP OPERATING AS A VIRTUAL LANDING STATION.

kilometers throughout the country. In addition, the backbone fibre market is liberalized with several providers including the country’s power utility. In fact the latter, Kenya Power and Lighting Company, has emerged as the largest wholesale fibre operator in the country. These developments have lowered the cost of domestic IP transmission, facilitating ISPs connecting to KIXP. Fibre networks are built to the borders of several neighbouring countries which has reinforced KIXP’s attractiveness as an East African hub; a second IXP has been established in Mombasa, site of the undersea cable landing stations. This has attracted international operators to the exchange. In 2011, over half of the Autonomous Systems Numbers (ASNs) routed through KIXP originated from more than a dozen foreign countries (Mwangi 2012).

In Argentina, ISPs outside large cities have high domestic transport costs exacerbated by limited competition. ISPs and citizens in these areas pay higher wholesale and retail costs than those in main urban centers, impacting the growth of the Internet market. The Argentine Internet Chamber (CABASE) an association of ISPs that operates the IXP NAP Buenos Aires spearheaded an initiative to connect these regions. Connecting regions in Argentina allowed them to exchange local traffic and interconnect through NAP Buenos Aires, forming a virtual IXP with national reach. The first node was established in 2011 and to date, nine regional IXPs are operational, connecting over 80 network operators through a central routing hub in Buenos Aires. By aggregating outbound traffic at the IXP, small network operators were able to negotiate better contract terms with upstream transit providers. Prices in the national transit market have declined to about US$40 per Mbps per month (Galperin 2013).

The growth in domestic IP traffic can attract international bandwidth providers, and can be particularly important for landlocked countries. One option for a landlocked country is for international IP-transit providers to establish a POP operating as a virtual landing station. Such is the case in East Africa where SEACOM, an undersea fibre optic cable company, has established POPs in Rwanda and Uganda.

An additional infrastructure trend is the globalization of IXPs as they expand their services outside their home countries. The Amsterdam Internet Exchange (AMS-IX) is at the forefront of this trend, billing itself as the most international IX in the world with over three quarters of its connected networks coming from outside the Netherlands.24 AMS-IX helped established the Caribbean Internet Exchange (CAR-IX) in Curacao in 2008, and assimilated into the AMS-IX global network in 2013. AMS-IX has created a POP in Hong Kong, the first such platform allowing remote peering from Asia into Amsterdam. AMS-IX is also partnering with the Kenya Internet Exchange Point (KIXP) and undersea cable provider SEACOM to establish a regional exchange for East Africa that will also support virtual peering to Amsterdam (AMS-IX 2013). The Dutch exchange recently announced plans to set up several exchanges in the United States as part of the Open-IX initiative. This aims to introduce neutral multilateral peering in order to reduce costs for major content providers such as the video streaming company Netflix.25

THE LONDON INTERNET EXCHANGE (LINX) HAS A STRONG OUTREACH PROGRAM REPRESENTING ITS MEMBERS ON IMPORTANT PUBLIC POLICY ISSUES. IT NOTES: “BY DOING SO, WE ARE NOT ONLY WORKING TOWARDS THE GOOD OF OUR MEMBERS, BUT THE INTERNET AS A WHOLE.”

Expanded IXP Services

As IXPs grow, they often evolve from a basic switching and routing service to become centers of Internet expertise in the country. This know-how allows them to begin to provide other services, supplementing the critical Internet infrastructure that has been put in place. Examples include IPv6, network security (e.g., CERT), mobile peering, and root servers.

In addition, IXPs can play a catalytic role promoting and nurturing the country’s Internet industry assisted through cooperative partnerships with other IXPs, regional Internet registries and international organizations.

The strong technical bond between the IXP and its members can be leveraged into industry promotion to the benefit of the

24 https://www.ams-ix.net/connect-to-ams-ix/benefits-of-connecting/
national Internet ecosystem. This is particularly important in countries that lack strong Internet associations. Given the importance of the Internet in any society, it is critical to have a group lobbying for sustainable and progressive policies. The London Internet Exchange (LINX) has a strong outreach program representing its members on important public policy issues. It notes: “By doing so, we are not only working towards the good of our members, but the Internet as a whole.”

**IXP Economic Impacts**

The direct financial benefits for ISPs of an IXP have been demonstrated above. In addition, IXPs offer benefits beyond the measurable financial advantages. Although these spill-over impacts are often not precisely calculable, the improvement in quality and reduction in cost generate significant gains for ISPs, consumers, content providers, governments and others. National technical human capacity is also raised with IXPs helping to make the Internet more sustainable (table 4.4).

<table>
<thead>
<tr>
<th>Sector</th>
<th>Impact</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall economy</td>
<td>Increase in GDP</td>
<td>Investment in network infrastructure. A number of studies have demonstrated the impact on economic growth from investment in telecommunications.</td>
</tr>
<tr>
<td>Overall economy</td>
<td>Increase in GDP</td>
<td>Increase in broadband access. There is growing research citing the relationship between broadband penetration and economic growth.</td>
</tr>
<tr>
<td>ISPs</td>
<td>Lower costs</td>
<td>Exchanging traffic domestically is generally cheaper than IP transit.</td>
</tr>
<tr>
<td>ISPs</td>
<td>Increased revenue</td>
<td>Triggers additional domestic traffic increasing revenues (Kende and Hurpy 2012)</td>
</tr>
<tr>
<td>Consumers</td>
<td>Lower costs</td>
<td>Reduction in Internet access fees and/or increase in speeds due to lower ISP costs.</td>
</tr>
<tr>
<td>Content providers</td>
<td>Increased revenue</td>
<td>Lower latency increases revenue (Nokia 2009). According to a Latin American study faster broadband speeds from IXPs would have a GDP impact of US$915 million (Telecom Advisory Services 2013).</td>
</tr>
<tr>
<td>Government</td>
<td>Lower costs</td>
<td>Greater efficiency through online public services (e.g., KRA)</td>
</tr>
<tr>
<td>Local computer equipment and software suppliers</td>
<td>Increased sales</td>
<td>Growing domestic Internet market triggered by IXP will generate higher sales of computer hardware and software.</td>
</tr>
</tbody>
</table>

Table 4.4. Economic Benefits of IXPs

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26 [https://www.linx.net/about/index.html](https://www.linx.net/about/index.html)