



AFRICAN UNION COMMISSION



GRAND DUCHY OF LUXEMBOURG  
Ministry of Foreign Affairs

Directorate for Development Cooperation



European Union Africa  
Infrastructure Trust Fund

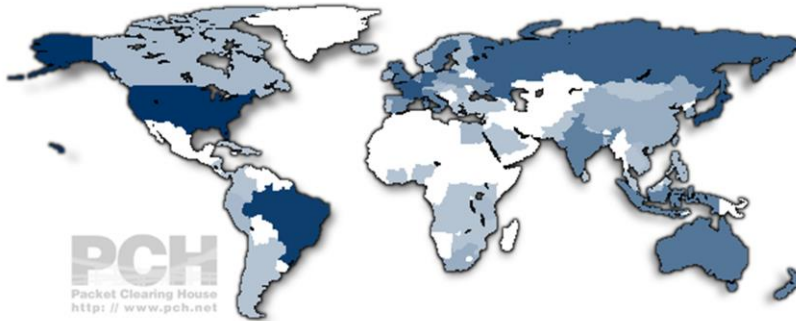
# Introduction to Internet Exchange Points

## Concept and Models of IXPs



# **OVERVIEW OF IXPS AROUND THE WORLD**

## IXP density around the world



- 91 countries with IXPs
- 107 countries without IXPs
- America, Brazil and Europe have the highest density of IXPs
- North, West Africa and Middle East are regions with least IXPs

# IXP Growth Per Region

Region	Internet Exchange Points				Domestic Bandwidth Production			
	Feb 2011	Feb 2012	Net Change	Percent Change	Feb 2011	Feb 2012	Net Change	Percent Change
Africa	21	21			3.23G	5.19G	+1.97G	+61%
Asia-Pacific	76	76			1.14T	1.3T	+157G	+14%
Europe	138	138			6.2T	8.63T	+2.44T	+39%
Latin America	34	34			61.8G	108G	+46.2G	+75%
North America	88	89	+1	+1%	877G	982G	+105G	+12%
<b>Total</b>	<b>357</b>	<b>358</b>	<b>+1</b>		<b>8.28T</b>	<b>11T</b>	<b>+2.75T</b>	<b>+25%</b>

- Latin America recorded the highest percentage growth
- Europe has the highest number of IXPs and aggregate traffic
- Asia-Pacific exchanges more traffic than N.A despite having less IXPs
- Africa 2<sup>nd</sup> in % growth with lowest number of IXPs and traffic exchanged

## Summary of North America IXP

- Due to the history of the Internet and the US the first IXP's known as Federal Internet Exchanges (FIX) East and West were built in 1989 under the NSFNET
- Soon after the first Commercial Internet Exchange (CIX) was built on the West Coast.
- In 1990 the 1<sup>st</sup> commercial IXP Metropolitan Area East (MAE) on the East Coast (Wash. DC)
- Thereafter the NSFNET awarded contracts for the running of 4 Network Access Points (NAPs)
- Over the years traffic reduced from the NAPs to Private Interconnections
- There are 89 IXPs in the US today most of which are **commercially operated.**
- Most of the IXPs are owned and operated by Data-Center companies

## **Summary of Latin America & Caribbean IXPs**

- The LAC region is as diverse as the Asia-Pacific region.
- The IXPs are commonly referred to as Network Access Points (NAPs)
- Brazil and Argentina are the most developed in the region.
- Brazil has the highest number of IXPs with 9 run by PTT metro a non-profit organization supported by the CGI
- Policy and regulations vary from one country to another for instance Chile requires each IP operator connect to a NAP
- Regional connectivity for the region happens mostly in Miami, USA following historical reasons
- The Caribbean Islands of Haiti and Netherlands Antilles have IXPs.

## Summary of Asia-Pacific IXP

- There is a large difference in the countries within Asia on the level of Internet access and connectivity.
- First free IXP in Asia was Hong Kong Internet Exchange (HKIX) administered by the Chinese University of Hong Kong (CUHK).
- IXPs in Asia have been formed through various models but largely remain non-profit entities either through academia or ISP association.
- Most of the large IXPs in Asia are located along the major cable landing points such as Hong Kong, Singapore, Tokyo and Seoul
- Unique Language is one of the key factors that has driven growth of traffic in the Asian-Pacific region.
- Presently there 20 Countries with IXPs out of the 58 countries under the APNIC region representing 34%.
- Policies and regulation vary from one country to another for instance Malaysia requires operators to connect to IXPs.

## Summary of IXPs in Africa (2012)



➤ 26 IXPs in Africa of which only 20 are known to be operational

➤ 21 African Countries (39%)

➤ South Africa (3), Tanzania, Nigeria and Kenya (2) are countries with more than 1 IXP

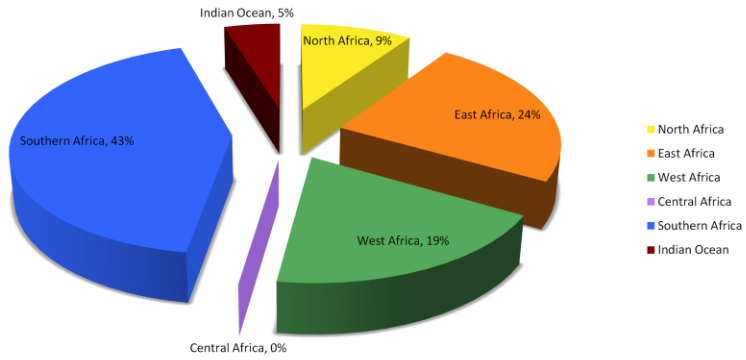
➤ West Africa has lowest number of IXPs by ratio (30%).

➤ New IXPs launched in Lesotho and Sudan in 2011



# Operational IXP distribution by Region (2012)

Africa IXP Distribution by Region



## **THE IXP CONCEPT**

## **IXP Description**

- An Internet exchange point (IXP) enables local networks to efficiently exchange information at a common point within a country rather than needing to exchange local Internet traffic overseas.
- Therefore an IXP is a component of Internet infrastructure that can increase the affordability and quality of the Internet for local communities.

# IXP Analogy

## Airports and IXPs

- Objective of airports is offer an efficient transit point for passengers – Similar to IXPs
- Airlines are traffic driven similar to Internet carriers/operators.
- Destinations for both Airlines and Internet Carriers are predetermined based on the locations value proposition and potential traffic volume
- Most importantly the facility's ability to attract more carriers and efficiently handle the traffic
- Facility features and services are value added services

## Airport Example: DXB

Growth in traffic at Dubai International Airport<sup>(1)(2)</sup>

Airlines	1985	1990	1994	1998	2002	2006	2010
Passenger movements	3.775 million	4.347 million	6.299 million	9.732 million	15.973 million	28.768 million	47.181 million
Airfreight movements (tonnes)	99,338	144,282	243,092	431,777	764,193	1,410 million	2,270 million
City links	19	36	54	110	170	195	210
Weekly scheduled flights	N/A	N/A	N/A	2,350	2,850	4,550	6100
Airlines	N/A	N/A	N/A	80	102	113	135

- The 4<sup>th</sup> busiest by International passenger traffic and 14<sup>th</sup> busiest by overall passenger traffic.
- 6<sup>th</sup> Busiest by cargo traffic as of 2012
- In 2010 DXB handled over 47.2Million passengers.
- Plans are underway to extend the airport to handle 80million passengers by 2012 and 90 million by 2018.
- Shopping, real-estate and regional financial hub status in addition to ease of connecting eastbound and westbound attract passenger traffic

## How IXPs Work

- The Internet is an interconnection of networks, each controlled by separate entities
- Those entities are generally called Internet Service Providers (ISP), and the networks they control are called Autonomous Systems (or AS) [RFC1930](#).
- In order to have connectivity to the "global Internet", the AS of an ISP must be connected to the AS of at least one other ISP which already has "global Internet" connection.
- This is called "buying transit", as the process usually involves an economic transaction.
- Autonomous Systems are interconnected via the BGP protocol [RFC4271](#).

## How IXPs Work

- All Internet Service Providers must buy transit, with the exception of a small number of very large ISPs (called "Tier 1" ISPs), who get global Internet connectivity simply by being interconnected with each other.
- In this model, all Internet traffic flowing between smaller ISPs (also called "Tier 2" ISPs) has to pass through their upstream providers' networks.
- Some of the Tier 2 ISPs decide to interconnect their AS directly, in order to reduce the amount of different networks (the number of 'hops') the traffic has to traverse, and at the same time save some transit costs. This practice is called "peering".

## **IXP Do's and Don'ts**

- IXP's are not, generally, involved in the peering agreements between connected ISPs;
- IXP's do not provide services that compete with its members
- IXP's do however have requirements that an ISP must meet to connect to the IXP;
- All IXP's have rules for correct use of the IXP.

## **STARTING AN IXP**



## Starting an IXP

- It is not possible to define a specific set of instructions for starting an IXP; every new IXP will face different challenges, and operate under different economic, technical and legal circumstances.
- However, the experiences of the existing IXP's will aid the discussions for the stakeholders to reach mutual consensus.

## **IXP STARTUP CHALLENGES**

## IXP Startup Challenges

- Most IXP established will experience low traffic volumes. This in itself is a cause for concern for most members interested in helping to establish an IXP
- The incumbent operator often resists connecting to the IXP. This is attributed to the perception that they will lose their traffic by peering with customers.
- The lack of full technical understanding about how the IXP operates and sufficient technical capacity to setup the IXP is a hidden concern for some operators.
- The existing regulatory regime and policies may hinder the growth of the IXP. For instance policies that inhibit competition on broadband terrestrial infrastructure may limit the options available for local interconnection.

## IXP Startup Challenges

- In many emerging Internet economies there are challenges on broadband terrestrial infrastructure (such as fiber and copper) that range from availability, costs, and quality of service.
- Where broadband terrestrial infrastructure challenges are prevalent, the use of wireless solutions in both open and closed spectrum is dominant but prone to interference resulting in poor reliability. As a result, this can affect the use of the IXP as a reliable peering point.
- Implementing a sustainable model to support the IXP operations is often met with some resistance. This is due to the perceived low value derived by members from peering at the new IXP.

## **IXP MODELS**

## **Institutional and Operational Models for IXPs**

- A variety of institutional models have been adopted to operate IXPs. They fall into four categories:
  - Nonprofit industry associations of ISPs
  - Operator-neutral commercial and for-profit companies
  - University and government agencies
  - Informal associations of networks

## **Commercial vs. Non-Commercial**

- Most European IXPs grew from non-commercial ventures, such as research organisations
- Most African IXPs were established by ISP Associations and Universities
- By comparison, in the US the majority of IXPs are commercial, and some commercially run IXPs have emerged in Europe
- Most of the emerging IXPs have opted for a non-commercial approach.

## Why Consider a non-Profit model

- Most emerging IXPs have a common objective of their founders to improve Internet connectivity rather than being built as a company.
- The involvement of non- commercial entities such as NRENs, ccTLDs and governmental institutions, it is easier to establish an IXP as non-profit entity
- A non-commercial entity is possibly better placed to maintain neutrality.



## IXP Neutrality

- Whether commercial or not, virtually all IXPs are owned and managed neutrally with respect to carriers, ISPs and co-location providers.
- An example that is often quoted is a group of IXPs in the US, which are owned and run by a carrier. The only circuits that may be used to gain access to the IXPs must be purchased from that carrier, thus producing a monopoly situation.
- Many ISPs have expressed strong feelings about the importance of neutrality of IXPs, and most of the larger European IXPs attribute their success to their neutrality.

## Cont'd ...

- IXP generally prohibit themselves from carrying out any activity that may compete with member/customer business activities.
- If an IXP competes with members/customers it could lose their support.
- The important point is that the ownership and management of the IXP should always remain neutral.

## Ownership

- Neutrality could be compromised if a member ISP owns parts (such as equipment, etc) of the IXP and is acquired over by another organisation
- The new owner may not honor previous arrangements and may impose their own limitations that are unfriendly to the IXP members
- The concern is the potential for disruption or even complete breakdown of the IXP should a major change occur to an involved party who has title to part of the infrastructure.

## Cont'd ...

- Many IXPs begin with donations of equipment, rack space, labour and other assistance - that is part of the co-operative nature of most start up IXPs.
- In case of donations, sponsors should put in writing the nature of the agreement for the IXP to use the equipment.
- It is the responsibility of the IXP to consider maintenance and insurance of the equipment
- Many successful IXPs have worked well by existing with some risk, on the understanding that, as a co-operative organisation, it would be in no single entity's interest.

## Cont'd ...

- In many examples of the creation of an IXP there is no formal body - the IXP is run and managed by general consensus between the parties involved (often the ISPs which will benefit from the presence of an IXP).
- This is probably the most efficient and easiest mechanism for a start up IXP.
- There are issues that arise as an IXP grows that suggests that a 'free form' purely consensual based model will not scale.
- The 'consensual' based model can still be true when the IXP has been developed from an established organisation such as a research or academic institution.

## Cont'd ...

- Whilst the institution itself will probably have well defined management structures for its original purposes, these may not be particularly applicable to the management of an IXP, and in some cases could be a drawback.
- These are some of the reasons why a nascent IXP should consider its formal management structure as early as possible.
- There is no one right management model, but careful consideration of the future management of the IXP
- The structure should assist the IXP to be self-determining, remain within legal and regulatory constraints, maintain neutrality and establish financial security.

## Scope of the IXP

- The scope of activities that the IXP should carry out is worthy of early consideration.
- Although this is likely to be a matter for continual assessment as the IXP grows, and the profile and requirements of its members changes
- Some IXPs limit themselves to purely providing a switched infrastructure,
- Others offer extra technical services (e.g. route servers, private interconnects)
- some IXPs carry out non-technical activities for the benefit of its members, acting, to varying extents, as industry associations.

## Cont'd ...

- These latter activities can be contentious, some ISPs want their fees to fund only the IXP physical infrastructure.
- Also these activities can often be country specific, and therefore being of limited benefit to ISPs not based in the country of the IXP.
- Most IXPs have mailing lists and meetings for their members.
- This means the IXP can be a natural forum for discussion of subjects of interest to the industry in general.

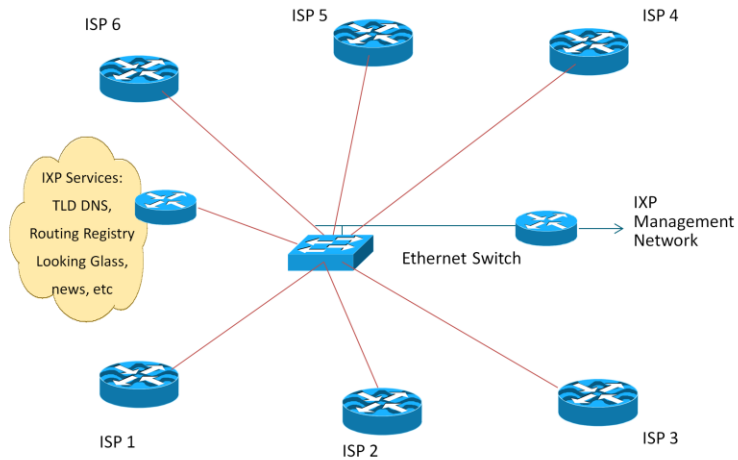


## Cont'd ...

- How far an IXP should involve itself in these activities is, of course, a matter for the individual IXP, its mandate, and its members wishes.
- Whatever involvement the IXP decides to have outside of providing the basic switch infrastructure, it is important that it has the support of its membership, and that the activities are documented so that there is transparency for existing and prospective new members.

**IXP INFRASTRUCTURE**

## IXP Architecture: Layer 2



The vast majority of IXPs have adopted a layer 2 switched Ethernet architecture.

- There are examples of other architectures such as ATM and FDDI, however, these are not common.
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# IXP Equipment

- **The IXP Core is an Ethernet Switch (Mandatory)**
  - Therefore invest in the best and most expandable equipment that its financial circumstances allow.
  - Having 2 switches is good for redundancy if the funds can allow.
  
- **Address Space (Mandatory)**
  - The IXP will require IP address space for the peering Switch fabric. IP addresses are requested from the regional RIR (AfrINIC)
  
- **Other Mandatory IXP equipment:**
  - Where the IXP is located in a datacenter other mandatory equipment are built into the facility. Where the decision is to host the IXP outside a datacenter facility, additional equipment will be required and are discussed in the IXP location slide.

# IXP Equipment

- **Route Server (Optional)**
  - During the initial stages of setup having a Route Server provides ease of configuration for new members
  - Direct peering between the IXP members can be implemented in the absence of a Route Server
  
- **Web and Mail Servers (Optional)**
  - An IXP will require servers to host email, mailing list, website and monitoring (usage stats, etc)
  - Where there are limited funds, members can offer to host the services on their services.
  
- **Transit Router (Optional)**
  - This will be to provide Internet access to the IXP website, email and staff Internet access.
  - Transit can be provided through a members IXP Router on a different interface.
  
- **Route Collector (Optional)**
  - Also referred to as a looking glass which assists IXP members with troubleshooting. It can also be used to collect routes for statistics measurements.

## Location

- The location of the IXP is very important.
- The IXP location should be neutral and low cost.
- In considering the IXP location the following factors should be considered;
  - i. Space
  - ii. Environmental Control
  - iii. Security
  - iv. Power
  - v. Access to terrestrial Infrastructure
  - vi. Cabling
  - vii. Support

### Space

Initially, the amount of rack space required needs to be determined. A major factor is whether the IXP will allow members to co-locate router equipment at the IXP. (This also affects considerations of telco availability - see below). Where an IXP is located in a commercial co-location facility, members may take (or already have) their own rack space in the facility, and can connect a router in their own rack space to the IXP switch infrastructure with an in-building (or on-campus) LAN connection. In this case the IXP may not need to house member routers. However, it is likely that at some stage there will be prospective members who do not wish to have their own presence in the facility, or the facility may become full. At this point the IXP will need to have adequate space to co-locate member router equipment. However much space the IXP expects it will need, it is common to find that the IXP outgrows it. Some co-lo companies will allow space to be reserved at a relatively low cost; this option is worth considering to accommodate future growth with the minimum initial outlay.

If the facility does not allow member ISPs to have their own rack space, clearly the IXP will have to house the member router equipment, and ensure telco access to terminate member WAN circuits. The problems in providing adequate space and access is perhaps the major reason that most European IXPs have moved or expanded into commercial co-location space.

Another factor for the trend towards sitting IXPs in commercial co-location facilities has been the increase in availability of high quality co-lo space across Europe. Many of the organisations providing such space did not exist when the older European IXPs were established but now the choice is quite wide in a reasonable number of European metropolitan centres, and a number of established IXPs have taken advantage of this and expanded into these facilities. It should be noted, however, that the expansion would appear to be largely in countries and regions already well served by IXPs, and not so much in the countries and regions where new IXPs are being formed. Several commercial co-lo companies had planned aggressive expansion into these areas, but the downturn in communications businesses would appear to have forced many of these plans to be shelved.

## **Security**

IXPs often become critical to their members' businesses, so it is important that the site of the IXP is as secure as possible. Commercial co-lo companies usually have sophisticated security systems, some elements to consider when looking for space are: 24x7 security manning, CCTV coverage (inside and out), and multiple level access control (site, building, room, rack/cage). The latter is worthy of particular consideration where the IXP is situated in shared rack space. Whatever security systems are in place, they need to be balanced with ease of access for IXP staff. Ideally, access should be available 24x7, and it worth making some effort to ensure co-lo staff are familiar with IXP staff. Where IXP members have equipment co-located in the IXP consideration should be given as to whether they are allowed unaccompanied access. This may be acceptable and pose little risk in the early days of an IXP, but as members rely more and more on the IXP it is probably wise to limit access to accompanied visits only.

## **Environmental control**

The co-lo space should be adequately cooled, with high quality air conditioning. Additionally, robust fire detection and suppression systems should be in place.

## **Power**

Most modern switching and routing equipment has the capability of redundant PSUs. To take advantage of this feature the co-lo should be able to provide at least two power supplies, preferably from diverse parts of the electric companies supply network. There should also be on site generators, with battery back-up/switch over to protect against total supply failure. The IXP may also wish to consider having it's own non-interruptable power supply, this is probably most important where the co-lo company cannot satisfy the requirements above.

## **Access to terrestrial Infrastructure**

Most existing IXPs allow members to co-locate routers at the IXP or are in a site where members may have their own rack space. It will be important to the members to have access to as many telcos as possible, therefore it is in the interest of the IXP to select a site with access by multiple carriers, even though this is not of direct benefit to the IXP itself. In situations where the telco market has not been opened to competition, it is worth discussing with the co-lo company their capability to allow multiple carries into the site in the future. There are two main factors, the physical - is there or will there be, adequate duct capacity, and commercial, are there any constraints on telcos accessing the site (e.g. local planning controls, ownership of the co-lo facility).

## **Cabling**

Given that a large IXP is likely to have 100+ members, many with 2 or more connections to the IXP, consideration should be given to the amount of space available for cabling. Also, any conditions or requirements the co-lo company may put on cabling need to be clearly understood.

## **Support**

Most commercial co-lo companies offer various levels of technical support. These services can be useful for the start up IXP that may not have staff available 24x7 to support the IXP. This can be quite an expensive option though, also the technical ability of the staff can be quite limited. If co-lo staff are going to be involved in support it is important that they understand the critical nature of the IXP, and are familiar with the role it plays in the Internet infrastructure.

# IXP Services

- There are a number of basic services that an IXP can offer to its members beyond the shared switch infrastructure.
- These services are at the discretion of each IXP and do not in any way compete with its membership.
- The following is a list of basic services that can be offered by the IXP
  - i. Shared switch infrastructure
  - ii. Website
  - iii. Mailing list
  - iv. Member route hosting/co-location
  - v. Route collector
  - vi. Route Collector
  - vii. Private Interconnects
  - viii. IPv6 and Multicast Services
  - ix. Multi Site Access
  - x. Industry Association & Policy
- Other IXP Value added services will be discussed in the next session

## Web site

It is almost inconceivable that an active IXP would not have a web site, but the content of that web site is not always given a great deal of consideration. At the very least it should outline the model and principals of the IXP, the cost and conditions of joining, and contact details for the IXP operator. Obviously a web site can be a vehicle for vast amounts of information, and the maintenance overhead of a very large site can be high, so in a start up situation it is probably advisable to keep the content to a minimum, but to ensure it is current. There are, however, some services that can be provided via a web site that an IXP may wish to consider in addition to the minimum above. These are the provision of statistics and a 'peering matrix'. Many IXPs provide publicly available statistics on the traffic through the IXP, and whilst this is not strictly speaking a service to the members, it performs a useful function to advertise the importance of an IXP in the Internet infrastructure. A peering matrix, sometimes obtained automatically from questioning the routing databases, indicates who is peering with whom amongst the IXP members. This can be particularly useful for new members when considering whom they may wish to, or be able to, peer with.

## Mailing lists

As mentioned above, it is extremely useful to have at least one mailing list for the IXP operators and members' operational personnel to discuss technical matters concerning the IXP. Many IXPs run multiple mailing lists, to discuss various aspects of the IXP. Whatever mailing list structure an IXP decides to operate it is important that the persons using the lists understand their use. Typically, the people on the lists will not appreciate off-topic postings or abuse of the lists.

## Route Collector

As mentioned elsewhere, some IXPs provide their members with access to a router connected to the switched infrastructure that all members' networks peer with. This router listens to all route announcements but makes no route announcements of its own. It is often a useful fault finding tool for a member to be able to 'view' the IXP via this router, particularly when they do not have visibility of the exchange via their own connected router. The number of potentially available routes at the IXP can also be ascertained from such a device. This information can be useful when marketing the IXP to encourage new members to join.

## Member router co-location

The question of whether an IXP will allow member routers to be co-located in the IXP has been discussed previously, but where this service is offered consideration should be given to the practical aspects. Space, power, cooling and other environmental conditions must be taken into account. Physical access to the IXP must be provided for installation, upgrade and maintenance. 'Out of Band' comms access may be required, involving telco circuits and terminating equipment. It may be the case that an IXP must offer this service due to its location – it may not be possible for members to have their own local co-lo space if the IXP is not situated in a public co-location facility. Also, the IXP may wish to encourage members, who do not wish to take their own space, this becomes more common when members are being solicited from regions remote from the IXP. Whatever the circumstances a start up IXP is recommended to consider the implications carefully.

## IPv6 and multicast

Some of the longer established IXPs are offering facilities for members to use IPv6 and multicast. Currently, most IXPs offering either or both of these facilities are doing so on a test or trial basis, and they are provided on infrastructures independent of each other and the main IXP. As these technologies are adopted by more ISPs, (in particular IPv6) the implications will need to be considered by all IXPs, and whilst an IXP starting up today may not need to concern itself with this immediately it would be appropriate to take the potential short term developments into account.

## Private interconnect

The concentration of ISP connections at an IXP can make it a very convenient place for one ISP to have a direct physical connection to another where their router equipment is co-located and with whom they exchange significant traffic. Some IXPs prohibit this, whilst some encourage it, so there are clearly two schools of thought. Prohibiting the practice will avoid any issues of responsibility for the IXP, stop any ISPs potentially taking advantage of the IXP's facilities to reduce their co-lo costs, and possibly encourage ISPs to peer 'publicly'. Encouraging the practice will increase management and responsibility overhead for the IXP but reduce the traffic through the shared switching infrastructure. (It should perhaps be noted that it might not be in the interest of a start up IXP to reduce the traffic through its own infrastructure.) At least one IXP also offers this service for members who do not have router equipment co-located within the IXP, but within the same co-lo facility.

## Route servers

Some IXPs offer a route server facility. This is typically a device that interrogates routing registries, builds a database of the entries in the registries for the member networks, and provides a routing table based on this information. An IXP member's router may then build its routing table with just one peering session with the route server rather than taking many routing tables from all its peers. The principal aim is to reduce the processing power required in the member router connected to the IXP, however inconsistencies in the routing registries tend to make this unreliable.

## Trade association activities

Some IXPs provide services unrelated to the exchange of Internet traffic. It is understandable that an organisation such as an IXP, involving many ISPs might well become a forum for debate about industry issues, but whether the IXP should actively involve itself is a contentious issue. Some ISPs will not want their membership fees spent on anything other than the switching infrastructure and its direct support, they will wish to take care of trade association issues via alternative means. Trade association activity tends to be country specific, ISPs from countries other than that in which the IXP is sited will not necessarily benefit from trade association activities. Also, where the membership is made up of ISPs of greatly differing sizes their requirements from a trade association are likely to be quite different, and in some cases requirements



may even be diametrically opposed. For these, and possibly other, reasons, the majority of IXPs actively avoid becoming involved in these activities. This being said, an IXP, particularly in a start up phase where it's members are of a similar size and a relatively small number, could be a focus for the ISP industry, and a useful representative of its constituent members. Probably the most important requirement for an IXP considering such activities is that there is a very high level of consensus amongst the membership, and that the activities are reviewed regularly to reflect the change in members' requirements as the IXP grows.

**Multiple site access**

Many European IXPs have expanded to provide access to their switched infrastructure on multiple sites in a given Metropolitan area. Whilst it is unlikely that a start up IXP will need, or be able, to do this, the growth of the market place and the expansion of co-location facilities would suggest that a new IXP would be advised to keep up to date with potential new sites.

# Personnel

- It is likely that a start up IXP will not have any directly employed staff. However, it is important to think about the role and skill sets of the personnel.
  
- **Roles and Skills**
  - Management
  - Engineering and Technical Support
  - Office/Admin
  - Sales and Marketing
  
- **Future Roles;**
  - Future roles will require more specialized staff such as systems administration, webmaster, human resources, public relations, financial control and legal representation.

## **Management**

The person or persons responsible for overall management of the IXP will usually combine technical, administrative and management skills, and as mentioned, may well have been involved in the start up of the IXP. The person(s) will need a good understanding of the role of an IXP, its relationship with the member ISPs, and the IXPs place in the global Internet infrastructure. A good manager will also be able to guide and advise the member ISPs in the best way to build and develop the IXP, whilst recognising the members needs. A manager must be aware of the legal and bureaucratic aspects of running the IXP.

## **Engineering and technical support**

As the IXP becomes more important and critical to the members' operations, high calibre network engineers will be required to maintain the IXP. Engineers may be recruited from member ISPs, (member ISPs may be happier to see a good engineer move to an IXP rather than a competitor!), other ISPs, or possible other IXPs. It is quite unlikely that a candidate with little or no exposure to core IP networks would be suitable as a first engineer. However, high quality network engineers are not a common commodity, and as the IXP grows consideration should be given to training engineers in house. This adds to overhead of course, and it could be several months or more before an engineer is competent to have technical access to all aspects of the IXP. One role such a 'junior' engineer may be suitable for fairly quickly is first line technical support, as and when the demands on the skilled engineering staff are such that the more mundane duties can be delegated.

**Office/admin**

There will come a point as the IXP grows that the clerical and administrative duties will occupy a full time role. This is unlikely to be a simple secretarial role, and candidates should have some understanding of the role of the IXP and the peculiarities of an IXP compared with a normal commercial organisation. A first employee in this position should be an 'all rounder', possibly combining administrative with human resource and accounting skills

**Sales and marketing**

Whilst to some extent ISPs will find the IXPs they wish to join for themselves, it can be very useful to have staff dedicated to growing and marketing the IXP. Some ISPs may not be aware of the existence of the IXP; some may not fully understand the role of the IXP. Sales and marketing staff can also accelerate the joining process by assisting new prospective members in gaining membership. It is preferable, but by no means essential, that persons in these roles have some technical knowledge about the IXP, certainly they need to understand the role of an IXP, but it is quite feasible for in job training to provide this knowledge.

**Future roles**

As with any organisation that experiences continual growth staff in more specialised roles may be considered at some point. These roles are probably not appropriate to the start up IXP, or even the medium to large established IXP, but some roles that existing IXPs have employed specialised staff in are: systems administration, webmastering, human resources, public relations, financial control and legal representation.

**IXP WEBSITE BEST PRACTICE**

## IXP Website Best Practice

- In most cases an IXP's website is its initial contact and reference point for all interested parties.
- The best practice provides is a list of suggestions for consideration on your IXP's website.
- It is important to discern the IXP website audience. Those coming to the IXP website fall under 4 categories
  - i. Potential IXP Participants
  - ii. Current IXP Members
  - iii. General Public
  - iv. IXP Staff

## Potential IXP participants

- The most important target audience.
- Most IXPs are looking to increase the overall value of their IXP by gaining additional and valuable participants.
- Important information to this audience is;
  - i. Who are the current IXP participants
  - ii. Amount of traffic being exchanged at the IXP
  - iii. Technical setup and Rules
  - iv. Connection costs
  - v. Connection Procedure
  - vi. Contact information and FAQ

### **The IXP Members list would ideally contain at least the following information:**

- Member's name
- Member's website for more information
- Member's ASN.
- Member's port(s) size at the IXP
- Member's peering policy
- **Amount of traffic being exchanged at the IXP**
  - The industry standard seems to be based around providing a daily graph that displays five minute averages of the aggregated public IXP traffic.
  - A history of this traffic is also of interest to most potential participants as it shows an IXP's recent and past growth trends.
- Technical Setup and Rules**
- In order to give potential participants a clearer picture of what your IXP looks like;
  - the network topology and switches in use;
  - where you are located;
  - what rules may apply in connecting to your IXP
  - what traffic may or may not be exchanged over the peering infrastructure,
  - Provide a detailed technical set-up area on the website.
- **Connection Costs**
  - how much costs to peer at your IXP
  - Does your IXP have a one time connection fee or membership fee?

- Are there annual membership fees associated with your IXP?
- How much do you charge for the various speed ports on your switches?
- Do you charge these fees monthly, quarterly or annually?
- Are the participants expected to pay in advance or in arrears?
- What exactly do your fees include?
- A clear breakdown of all costs involved is extremely beneficial to any potential participant.

- **Connection Procedure**

- Your IXP may have particular joining requirements such as having an ASN
- Must be a legal entity in the country, etc
- Terms and conditions
- Articles of Association
- online application form
- Duration it will take to get his application approved
- when he connect to the switch
- when and how he can start peering and take part at the IXP as a participant

## Current IXP Members

- This category will frequently visit the IXP website and need to be properly catered for.
  
- Important information to this audience includes;
  - Peering information and tools
  - Usage graphs, statistics, network topology,
  - 24 hr Contact information
  - Development updates at the IXP (new members, planned maintenance, technical meetings, etc)
  - Regional updates such as peering events, reports from various regions, best practice information and links

**The IXP Members list would ideally contain at least the following information:**

- Member's name
- Member's website for more information
- Member's ASN.
- Member's port(s) size at the IXP
- Member's peering policy



# General Public

- Research entities are taking interest in the Internet and IXPs around the globe.
- In general they are looking for statistics and trends on the amount of traffic being exchanged at the IXP.
- The amount and type of participants that are present including their ASNs and where possible the prefixes being announced;
- Other IXP related information information such the IXP's year of establishment, brand of switches being used, services provided and more.
- In addition other non-research visits may be looking for more information such as;
  - What is an IXP
  - The IXPs background information (history)
  - Status of your IXP today

## IXP Staff

- As the IXP grows the IXP website becomes a useful communication tool for;
  - Technical staff and engineers
  - Administration and financial management
  - Sales and Marketing
  - Management oversight and reporting

### IXP staff

The IXP website can be an extremely useful tool and an efficient manner for your staff to communicate the latest developments with one another. As your IXP grows you will not only have engineers that will find the use of the website practical, but also administrators, financial personnel, management, marketing and possible others. Thus the website could be used to display information on participant application PROCESS, participant's ports, their contact details, invoicing details and the payment status, staff contact details and almost anything else that your staff wish to access from a central data point from anywhere in the world.

## Other Considerations

- The languages supported by the website is important in attracting more people to the website and it's information
- As the IXP grows having public and private pages might be necessary. For instance where staff or board members can have a private (secure/login required) space with tools and information for online collaboration.

# Acknowledgement and Attribution

This presentation contains content and information originally developed and maintained by the following organization(s) and provided for the African Union AXIS Project.



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**END**

