ITU Consultation on Best Practices for IXPs
Response of the Internet Exchange Federation (IX-F)

Introduction

The Internet Exchange Federation is the global coordinating body for the regional Internet Exchange Point Associations (IXPAs). It is therefore in an unparalleled position to reflect the views and experiences of the global IXP community. Working alongside the IXPAs, the Internet Exchange Federation is committed to furthering the development of IXPs throughout the world. As part of this mission, IXPAs are committed to developing, sharing, and continuously improving best practice information amongst the IXP community. On behalf of the IXPAs, the Internet Exchange Federation welcomes the opportunity to share this expertise with the ITU and looks forward to exploring ways in which it can be made available to a wider audience.

Purpose, Structure and Membership

IXP operators created the regional IXPAs to act as centres for the development and exchange of best practices and shared experiences. The IXPAs are established on a regional basis: AFIX for Africa, APIX for Asia and the Pacific, Euro-IX for Europe and LAC-IX for Latin America and the Caribbean. The Internet Exchange Federation, IX-F, provides coordination at the global level.

The regional IXPAs comprise some 450 member IXPs, including all or almost all of the largest[1] IXPs within their respective regions.

[1] The concept of "largest" IXP is a complex one, as relevant metrics for size include multiple factors, including number of participants, total volume of traffic passing over the Exchange, and percentage of global routing table visible at the exchange. This statement is understood to remain true for all these metrics.

What is an Internet Exchange Point (IXP)

Internet Exchange Points exist to facilitate the interconnection of Internet network and the exchange of Internet traffic. However, the same could be said of many other facilities too. The IXP community has therefore adopted, through IX-F a formal definition of an IXP[2]:

Definition of an Internet Exchange Point

An Internet Exchange Point (IXP) is a network facility that enables the interconnection of more than two independent Autonomous Systems, primarily for the purpose of facilitating the exchange of Internet traffic.

An IXP provides interconnection only for Autonomous Systems.

An IXP does not require the Internet traffic passing between any pair of participating Autonomous Systems to pass through any third Autonomous System, nor does it alter or otherwise interfere with such traffic.

"Autonomous Systems" has the meaning given in BCP6/RFC4271 , "A Border Gateway Protocol BGP4".

"Independent" means Autonomous Systems that are operated by organisational entities with separate legal personality.

Explanatory Notes

1. An Internet Exchange Point is a technical facility. This is distinct from the organisation that provides that facility, which might be termed an IXP operator.
2. An IXP is distinct from an Internet access network or a transit network/carrier.
3. The function of an IXP is to interconnect networks. An IXP does not provide network access or act as a transit provider/carrier. An IXP also does not provide other services unrelated to interconnection (although this does not preclude an IXP operator from also providing unrelated services).
4. An IXP exists to interconnect networks that are technically and organisationally separate.
    a. Without qualification the term "network" is too flexible and fails to identify the degree or kind of separation required. Once interconnected, separate networks are arguably part of the same network: the entire Internet is often considered a network, a network of networks.
    b. To resolve this terminological problem we employ the term "Autonomous System", which is the standard technical definition of a technically stand-alone network.
5. The network operators whose networks are interconnected in an IXP are sometimes collectively termed "IXP participants", which generalises the relationship between those entities and the IXP operator; IXP participants may be members of the IXP operator, customers of the IXP operator, or some other relationship.
6. An IXP is a facility where numerous participants interconnect (at least three); this distinguishes Internet Exchanges from bilateral network interconnection, in which one network connects to one other.

[2] See http://www.ix-f.net/ixp-definition.html

History of the IXPAs

Consistent with the development of IXPs worldwide, the first IXPA to be founded was in the European region, Euro-IX, which was founded in 2001. Euro-IX was defined as a European regional organisation, because its original members were European IXPs, but it was never exclusionary in practice. Initially, Euro-IX welcomed non-European IXPs to participate in its activities as guests, and in 2006 it created a category of Associate Membership to enable non-European IXPs to participate more fully.

APIX and LAC-IX were each founded in May 2010, by groups of IXPs in the Asian and Latin-American regions, entirely independently of Euro-IX.

The continual growth and interest by African IXPs in participating in Euro-IX information sharing activities led to consideration of whether Euro-IX should be reformed as a global organisation. Acknowledging the success of APIX and LAC-IX, IXPs decided it would be more appropriate and beneficial to create IXPAs for their own regions, focussed on and responsive to their own specific concerns, while sharing information and support between regions.

The advantages of regional IXPAs as opposed to a single global body were understood to include:

- Regional IXPAs could focus on best practices relevant and specific to each region, allowing diversity of advice appropriate to local circumstances, such as differences in local infrastructure;
- Regional IXPAs could take better account of relationships with other local stakeholders, such as national governments and regional intergovernmental bodies, and better avoid misunderstandings between participants caused by mistaken assumptions occasioned by differing regulatory approaches;
- Regional IXPAs would be more responsive to practical considerations, such as being able to hold events entirely within the region, reducing costs and enhancing participation;
- Regional IXPAs would enable full participation in governance and leadership by the participants from within the region.

In order to ensure that new regional IXPAs could benefit fully from relevant experience in other regions, it was decided to create IX-F as a federal structure. Its primary responsibility is to coordinate and facilitate the sharing of best practices and other relevant information between regional IXPAs.

The formal creation of IX-F was therefore initiated by the signing of a Memorandum of Understanding in November 2012, with the initial signatories as APIX, Euro-IX and LAC-IX. AFIX affiliated to IX-F by signing the Memorandum of Understanding in October 2014.

IXPAs are the source of widely accepted Best Practice for IXPs

IXP operators have long recognised the benefits of sharing relevant information and experiences and developing best practices. In order to do this most effectively, they created the Regional IXPAs to be the forum for sharing and developing such information and best practices, drawing on the wealth of experience of IXP operators themselves. As such, the IXPAs are widely accepted as the preeminent source of such best practice information.

The ITU Plenipotentiary Conference 2014 recognised the IXPAs' role when it instructed the Director-General of the Telecommunication Development Bureau to liaise with other relevant organisations aimed at making available widely accepted best practices for the design, installation and operation of Internet exchange points (Resolution 102 Rev Busan 2014).

The Regional IXPAs look forward to liaising with the Director-General of the Telecommunication Development Bureau, through the Internet Exchange Federation, so that these best practices can be made available to a wider audience, as the ITU Plenipotentiary intended.

Best Practice development by IXPAs

The IXPAs are recognised by IXP operators, and the wider stakeholder community, as the authoritative source of best practice development because of their governance and development methodology:

- As organisations controlled by the IXP operators themselves, IXPAs are *responsive* to the needs of IXPs.
- Being based regionally, IXPAs are *inclusive* and provide a structure for ensuring that operators from *all regions can participate in a leading role* in organisational governance.
- As *private* organisations, adoption of IXPA Best Practice report is *voluntary*. This makes it *flexible*, and *adaptable* to the specific needs of each IXP operator.
- IXP operators inherently have the greatest understanding of the challenges they themselves face. IXPAs enable IXP operators to ensure that Best Practice development is directed *pragmatically* towards what is most *useful to IXP operators*, rather than what appears susceptible to standardisation.
- IXP operators inherently have the greatest experience of operating IXPs, and therefore of what has been tried, and with what results. IXPA Best Practices therefore reflect *actual operational experience, rather than theoretical or laboratory results*.
- IXP operators are committed to continuously improving quality and resilience. Experiences and best practices are exchanged and shared through the IXPAs as a facilitator.
- IXPAs play a significant role in promoting, optimising and adding further diversity and scalability.
- IXPAs are a recognised and distinguished platform for the dialogue and exchange between IXPs, whether on a local, regional or a global level.

Examples of Best Practice programmes

Regional IXPAs have used this methodology to develop and share Best Practice programmes with the global IXP community. Attached in the appendix are examples of some of these programmes.

The Internet Exchange Federation looks forward to liaising with the ITU so that the output from programmes like these can be made available to ITU Members, and especially to any existing and prospective IXP operators that are not already engaged through their regional IXPA.

Cooperation between the IXPAs, governments and other stakeholders

IXPAs have long recognised that one of the key components of Best Practice programmes is a supportive and enabling policy environment. As such, IXPAs have sought to engage with governments and other stakeholders to promote the development of such an environment. The value for the development of IXPs of cooperation between stakeholders in a multistakeholder environment has been consistently recognised. The World Telecommunications Policy Forum 2013 (WTPF) was of the opinion that "effective IXPs often emerge where Member States have adopted multistakeholder policy processes, as IXPs rely on cooperation among relevant stakeholders" (Opinion 1), an opinion that was recalled by the ITU in Resolution 101 Rev Busan 2014.

As was the opinion of WTPF, multistakeholder cooperation should focus on "enable the emergence of Internet Exchange Points through the fostering of supportive policy environments" so as "to promote public policies aimed at permitting the local, regional and international internet network operators to interconnect through IXPs".

It is already common for individual IXPs in many countries to engage with their national governments "for the purpose of promoting policies aimed at creating an enabling environment for the interconnection of international, national and regional networks through IXPs", which WTPF recognised as "an effective way to improve international internet connectivity and to reduce the costs of such connectivity, with regulation only when necessary to promote competition". **The Internet Exchange Federation believes that there is a further opportunity for national governments and other stakeholders to learn about the experiences of IXPs in countries other than their own, through liaison with regional IXPAs facilitated by the Internet Exchange Federation**.

As stated by paragraph 69 of the Tunis Agenda, such multistakeholder cooperation should avoid intervening in "day-to-day technical and operational matters, that do not impact on international public policy issues", which remains the responsibility of the operators themselves.

Document status

This document, including its Appendices, is submitted on behalf of the Internet Exchange Federation (IX-F), with the support of AFIX, APIX, Euro-IX and LAC-IX.

Further information

For further information please contact:

Malcolm Hutty
Internet Exchange Federation
Email: malcolm@euro-ix.net
Telephone: +44 207 645 3500

Appendix I: Case Studies on Best Practice Sharing at Euro-IX Forums[3]

Introduction: the Euro-IX Forum meeting

One of the keys services the IXPAs offer are the face-to-face meeting with the members. This gives the IXPs an opportunity to come to together in an open friendly environment to discuss new technologies, new ideas, share experiences and learn from each other. IXPs from start ups to being more advanced benefit from the forums as there are different sessions on different topics.

Euro-IX Forums are currently held twice a year: there have been 26 forums since the programme was first instituted in 2002. In order to ensure inclusivity as well as to share out the logistical challenge, Euro-IX member IXPs take turns to host the forum. The most recent, the 26th Euro-IX Forum, was held in Marseilles hosted by France-IX. There were 126 attendees from 45 IXPs. The Euro-IX Forum welcomes participation from IXPs from outside the European region, and the 26th Forum was also attended by participants from IXPs based in Brazil, India, Japan, Nigeria, Uganda, USA and South Africa.

Customer views session	
What	A panel session where specially invited representatives of selected large networks discuss what they are looking for when choosing whether to join an IXP, and which IXPs to join.
Key benefits for network operators	An opportunity to convey key priorities directly to a large number of IXPs all at once, mostly at the chief-executive level, helping them to focus on what the network operator really needs them to deliver.
Key benefits for IXPs attending the forum	Helps IXPs understand from the 'other side' what they can do to help grow and improve the service(s) they already provide. Direct access to key decision-makers at major networks gives a unique insight into the thought-processes and key priorities for the "anchor networks" whose presence will attract other networks to join an IXP.
Knowledge share opportunities for new, smaller or remotely located IXPs	The selected networks speaking on the panel exemplify the large transit and content providers a small IXP needs to attract to generate a "critical mass" of participation: seeking to attract such participation is usually a key goal, and a major challenge, in the early lifetime of a new IXP. This session provides invaluable insights on how to do that as well as ideas on what networks to target for outreach. While larger, better established IXPs will likely already have these networks as participants, for newer and smaller exchanges this may be the first opportunity to learn first-hand what those networks really prioritise in practice.
Outreach opportunities for new, smaller or remotely located IXPs	The presence of key decision-makers from larger networks at a Euro-IX Forum gives IXP leaders from new and developing IXPs an unrivalled opportunity to promote their exchange by directly relating their offering to how the network operator has just described their own peering strategy, as well as the opportunity to make longer-term contacts and partnerships.

[3] These case studies were prepared by Euro-IX on the basis of their own experience. However all IXPAs conduct some form of member meeting, and each IXPA offers similar events with similar benefits to its members.

Technical sessions	
What	• A series of presentations and tutorials by IXPs for IXPs • Technology briefings from leading vendors of critical IXP technical equipment • Special technology briefings from individuals participating in development of technical standards of particular relevance to IXPs • "Lightning talks": short updates on recent experiences since the last Forum
Recent examples	• Switch family roadmap updates from leading vendors • Capability and timeline roadmap updates for new Ethernet standards • Security experiences at IXPs • Operational experiences: performing software and network upgrades in a high-availability environment.
Benefits for IXPs	While theoretical approaches to best practices in network maintenance abound, there is no substitute for practical experience. By meeting in a closed trusted environment away from customers and government regulators, the technical forum sessions have created a culture of frank information sharing on recent experiences (since the last forum) that enables the IXP community to learn from each others' experiences – including mistakes. Insights into forthcoming technology helps IXP operators plan their development, avoiding wasteful investment into the tail-end of a technology cycle. Frank information sharing between members of an IXP peer-group, and Euro-IX's culture of open challenge to vendor representatives helps early-adopter IXPs avoid known pitfalls with a new technology and IXPs that follow later to learn from the practical experiences of those that came before. Direct interaction with participants in standards development helps IXPs that are not sufficiently resourced to participate in standards development themselves to prioritise their engagement and influence outcomes.
Particular benefits for new and smaller IXPs	While the largest IXPs have substantial teams of technical experts to design, test and qualify implementations of the latest technology before it is put into operational service, smaller IXPs rarely have such a broad base of technical resource. By learning from the practices and experiences of larger IXPs that preceded them, smaller IXPs can gain the benefit of this investment without incurring the same costs. At the same time, it is also true that formal descriptions of best implementation practices – including advice from vendors – often assumes a skills resource base that is simply not available to many new, small and developing IXPs. By sharing information and experiences amongst each other they are able to access practical advice that is relevant to their own situation. Smaller IXPs also find it most difficult to dedicate resource to influencing standards development processes, and so benefit most from direct access at forum sessions to those who participate directly so as to help guide standards development to meet their own requirements too.

Research and Development	
What	In recent times with IXPs getting more and more traction, the education and research sector have had a growing interest in the operations of IXPs. There have been many presentations given by various research students on the technical ability of IXPs and different projects that are being studied at university to further develop IXPs. Additionally, the IXP community itself has sponsored R&D projects, carried out both within IXPs and by researchers commissioned by IXPs.
Benefits to IXPs	Further developments of software based automation is becoming a key topic in this area. More and more IXPs are interested in automating many of their daily function to support them and more importantly avoid human error.
Specific benefits to new and smaller IXPs	New and smaller IXPs often lack the research capacity and software development skills, and benefit particularly from leveraging projects commissioned by larger IXPs. It's useful for new IXPs to already deploy some of these technologies and for existing one to try them out and see if they scale to the size of their IXPs giving again the smaller ones feedback before they reach that stage.

Commercial affairs sessions	
What	• **Community building.** For IXPs to be successful in their area they need to be able to community build, and most IXPs do this very well. In this session IXPs can share ideas for topic that bring local communities together, building interest in participating in the IXP community not only as a facility for interconnection but also as a hub for industry news and the sharing of expertise. • **Marketing and social media strategies**. These sessions can include tips on how to target relevant messages and how to reach decision-makers in network operators who are typically bombarded with, and so inoculated against, sales messages from vendors. • **Reciprocal invitations between IXPs** for meeting attendance. IXPs regularly invite other IXPs to their meetings another way to learn and share ideas and experiences. • Service analysis and benchmarking
Benefits to IXPs	• Community building discussions can include how the IXP attracts attendees to their meetings, what's successful and what's failed, which gives others ideas for what to try and what to avoid. • Because IXPs share a common – and quite specific – marketing message they want to convey to prospective participants, and can benefit from collaborating to bypass defences erected against vendor sales campaigns. • A "guest IXP" presentation at another IXP's participant meeting can be a useful community-building tool, and is welcomed by IXP participants as it both demonstrates and reinforces the friendly, open and cooperative nature of the IXP community.
Specific benefits for new and smaller IXPs	While advice to IXPs generally can often focus on particular IXP segments (such as what the largest and most successful IXPs do, or what IXPs do when just starting up) a peer-group discussion between IXP leadership staff allows IXPs of all types to focus on what worked best for similarly situated IXPs, while also being stimulated with ideas from those in other environments that they might not otherwise have considered.

Regulatory Affairs session	
Policy updates	This session allows the Euro-IX Regulatory Affairs Officer to update the community on regulatory issues and policy development that potentially affects IXPs. The focus is principally on issues at a regional or global level rather than national regulation.
Engagement with the global community	This session also provides an opportunity for updates from, and co-ordination with the Internet Exchange Federation (IX-F)
Benefits to IXPs, especially smaller IXPs	Few IXPs have specialist regulatory affairs resource, and as such they have limited capacity to engage with relevant governmental organisations outside their own country (such as the institutions of the European Union, or the ITU). The availablility of a common resource that can engage with governmental stakeholders on behalf of the whole community saves costs and enhances capacity, ensuring that smaller the voice of smaller IXPs is also heard by policymakers.

Appendix II:
Further Case Studies in Best Practice Sharing and Collaboration

Introduction

According to Wikipedia 'a best practice is a method or technique that has consistently shown results superior to those achieved with other means, and that is used as a benchmark. In addition, a "best" practice can evolve to become better as improvements are discovered. (…) Best practices are used to maintain quality as an alternative to mandatory legislated standards and can be based on self-assessment or benchmarking.'[4]

Taking the above as a starting point before listing examples of best practices for IXPs, a few elements are worth noting. There is a referral to 'results' that have been 'consistently' proven to be better ('superior') when using the technique described by the best practice as a method of choice. Which suggest that one keeps the best practice in mind as a 'benchmark' when trying to tackle a specific challenge. It is (preferably) a documented approach, making it easier to share, and is based on lessons learnt by others who dealt with a comparable situation. An important factor of a best practice is that it is not written in stone and 'can evolve' as potential 'improvements are discovered' (learnt) and incorporated in a newer version of the practice. Also the fact that the use of the best practice is not 'mandatory' is an essential characteristic.

As mentioned in the Response IXP operators created the regional IXPAs to act as centers for the development and exchange of best practices and shared experiences for IXPs. As IXPAs are formed and controlled by IXPs themselves, they focus pragmatically and in a directly useful manner to actual operational challenges faced by IXP operators. It is in the clear interest of the IXP community that IXPAs promote an open interchange of ideas and experiences by offering, amongst others, fora, meetings, mailing lists and online resources to all stakeholders with an interest with regard to IXPs. This transparent, flexible and practical approach is exactly what leads to a pool of knowledge, including best practices, which is easily made available to anyone and can be used and adapted voluntarily and on an individual basis by any IXP.

Numerous areas and topics are covered in the interaction between the IXPs who form the IXPAs: these range from overcoming and solving technical problems and constraints, together with vendors and datacenters if appropriate, to commercial perspectives and what members and customers from IXPs need in order to make use of IXPs as easy, efficiently and effectively as possible. Also regulatory topics and engagement with policy makers make up an important part of work done within IXPAs.

[4] https://en.wikipedia.org/wiki/Best_practice

Both from an angle of providing resources on request as well as proactively informing and discussing issues with public officials and regulatory authorities.

IXPAs work together, but as they have been established regionally, they can individually cater towards their own constituencies: regions not only differ geographically and culturally, they also face different phases in ICT-development and challenges that (starting) IXPs run into. This is where a global IX-F adds value, as knowledge and experiences are shared between IXPAs: an African IXP might benefit of the lessons learnt by a European IXP to take the next step, and a South American IXP for instance can use the results of a technical project of an Asian IXP.

This Annex lists a number of examples of best practices with regard to IXPs as established by the IXP community: it aims to illustrate the aforementioned Response of the IX-F to the ITU consultation on Best Practices for IXPs[5], to which it comes as an attachment. As such these examples reinforce the statement that the 'IXPAs are committed to developing, sharing, and continuously improving best practice information amongst the IXP community'. The sharing, learning, developing and improving efforts within the IXP community, based on actual operational challenges and experiences are central to this, and the result is a knowledge pool from which best practices are distilled.

The ITU consultation calls on 'stakeholders' to 'elaborate and exemplify on the challenges faced and identify widely accepted best practices for the design, installation and operation of IXPs.' In order to do so one first needs to determine what an IXP actually is. As there is no formal ('mandatory') definition of the term, the consensus within the IXP community on what an IXP is, can actually be considered a first best practice in this area. The result, the adoption of 'a formal definition of an IXP', is included in the Response.

The first example described in this Annex is a form of information-sharing known as the 'Euro-IX Benchmarking Club'. This initiative is a means for IXPs to exchange data about their business and operations so as to enable them to compare their performances and policies. It is important to note that although it is called "benchmarking", it is not intended to set any kind of normative standard but rather to enable IXPs to compare themselves with other IXPs, including on metrics that are not normally made public.

IXPs have worked together for a number of years, and continue to do so, in the area of formulating a 'wishlist' of the various features they would like to see implemented in Ethernet (Switching) products they use. This list, considered a second best practice, acts as a consensus from the IXP community as to what vendors of equipment, used by IXPs, should offer in terms of hardware specifications and -options.

[5] http://www.itu.int/en/council/cwg-internet/Pages/consultation-june2015.aspx

In order to support IXPs in a start-up phase, or those who are facing significant challenges when taking 'the next step', the IXP community has launched a 'Twinning program'. A 'donor' IXP 'twins' with a developing IXP and supports it by for example providing funding to attend IXPA meetings or training and internships for engineers from the developing IXPs. This is example number three.

The Irish IXP INEX has developed and maintains an IXP management tool called 'IXP Manager'. This free software tool by now is used by many IXPs and is maintained and adapted based on community experiences and –feedback.

Again, the examples that follow are to illustrate the reasoning of the Response. The IX-F is more than happy to provide further information on examples mentioned as well as on other cases: either to the ITU directly, to (Sector) Members, or to any other interested stakeholder for that matter.

Euro-IX Benchmarking Club

Introduction - What is benchmarking?

Benchmarking is the exchanging of data between IXPs to enable members of the benchmarking club to compare performance, policies, and other relevant data. using metrics that are not normally made public. This is intended to provide each participating IXP with useful insights into how they compare with their peer group; it is not intended to set a normative standard nor to be a means by which IXP participants can measure "which is the best IXP".

Benchmarking helps IXPs to look up and outwards.

Benchmarking, especially if it is multilateral, needs an 'honest broker'. Euro-IX and IXPAs are in a good position to be the 'honest broker', via the Secretariat. The club was initiated in November 2004 as a means for IXPs to exchange data about their business so as to enable them to compare their performances and policies.

The Euro-IX benchmarking club

Membership is optional for Euro-IX members, although the design of the club is such that all members should be able to join and get some benefit - even if they do not fully participate.

The club is operated by the Euro-IX Secretariat, under the supervision of a small steering committee, elected by the club members.

Club decisions, where these need to be formally made - and including the proposed initial rule set below, are by simple majority of the participants. Where this isn't possible or practical for some reason, the issue is referred back initially to the Euro-IX Board and finally to a general meeting for resolution.

An essential attribute of the club is that IXPs should feel in control of any data that they contribute. So, the rules were designed to give confidence to participants, as follows:

1 Data contributed by individual members remains their property, and is stored in a confidential manner, such that no other member has access to it.
2 Data contributed by individual members will only be reported back to others in anonymised and aggregated form, unless the express consent has been given for it to be represented in any other fashion.

3 Data will be requested and contributed in specific categories. Members will only get reports back in categories where they contribute data in the form requested.
4 There is no charge for the service

Benchmarking data categories

The current data categories are:

- Prices
- Member/customer satisfaction
- Financial performance & margins
- Service delivery times
- Traffic metrics
- Financial policies (e.g. depreciation)
- Staff wages, bonus and other benefits (e.g. for engineers)
- Services
- Staffing (and what they do)
- Membership/customer base & growth rate in this
- Constitutional details (e.g. for membership organisations, does the membership approve the budget?)
- How is equipment maintenance handled (internally, with what sort of support contracts; externally, with what sort of notice to customers/members?)
- Network up-time
- Resellers

This is not meant to be a definitive or exhaustive list - the categories will be decided by the steering group - but subject to the overall approval of the benchmarking club.

Why should an IXP use Benchmarking

Benchmarking is a common practice and sensible exercise to establish baselines, define best practices, identify improvement opportunities and create a competitive environment within the organization. Benchmarking helps companies:

- Gain an independent perspective about how well they perform compared to other IXPs
- Clearly identify specific areas of opportunity
- Validate assumptions
- Prioritize improvement opportunities
- Set performance expectations
- Monitor company performance and manage change
- Improves understanding of the real opportunities and their priority at all levels
- Fosters a spirit of enthusiasm to do better
- Promotes discussion based on data rather than assumptions or emotion

After discussions with IXPs we've found the benchmarking at its best is used as a tool to help evaluate and prioritize improvement opportunities within IXPs. It helps identify;

- Techniques in which the IXP can grow
- Helps build and promote trust within the IXPs
- It helps smaller IXPs identify growth opportunities

The IXP Wishlist

With the constant development of video and cloud based services, Internet traffic keeps on increasing. Public peering via IXPs continues to grow in terms of traffic carried and the number of ports required at IXPs. Within the IXP community it is strongly felt that that having the right tools and features implemented in the equipment deployed by IXPs will play an important part of scaling Ethernet technology and meet the demands placed upon IXPs.

An document has been drafted within the IXP community, a continuing work in progress, outlining the various features which IXPs would like to see implemented in core Ethernet (Switching) products. The result can be considered to be a best practice as the wishes defined in the document should be understood as both logical AND wherever it makes operational sense. And they reflect the current consensus as to what vendors (preferably) need to support.

The document is self-explanatory, and the latest version can be found at https://www.euro-ix.net/m/cms_page_media/49/ixp-wishlist.pdf .

The Euro-X 'Twinning' program

IXP's tend to go through phases, from being a start-up to taking a next step in a growth cycle. Different challenges, or even road-blocks, might be faced, which often the IXP itself is not able to overcome. There might be limited or no funding, or lacking technical or operational support. It may not come down to an issue of money, it could very well be the case that the IXP is in search of technical information or hands on experience at another IXP which it simply cannot attain or find in its own region. This is where the 'Twinning program' steps in.

Some phases and potential challenges an IXP might run into:

1. *Planning:* This can range from a simple idea put forward by someone to a full plan with contracts already in place and construction work on the way. The IXP may simply require some technical advice or could be attempting to fully equip his IXP with donated equipment.

2. *Start-up:* This might range more from the actual implementation/construction phase of an IXP through to the IXP being set-up and possibly already having one or two connected ASNs. Once again assistance might be sought in all possible areas.

3. *Recently established*: The IXP is now "up and running" with at least three ASNs that are exchanging traffic over the IXP infrastructure. The IXP has been established for less than 24 months. Assistance might be sought in all possible areas.

4. *Long established:* The IXP has been established for more than a 24-month period and either at some point had or still does have more than three ASNs exchanging traffic over the IXP infrastructure. This IXP may be going into the next phase of development or may have run into some unexpected problems that it is now looking for assistance to rectify.

The sort of assistance that a particular IXP may require will vary from IXP to IXP and naturally region to region. Some of the main areas of need are classified in the following five categories:

1. *Information:*

   i. The translations of IXP related documents and manuals

   ii. Configuration examples for switches, with localized documentation

   iii. Localize training materials and tools

2. *Experience* (personnel):

   i. Hands on help at their IXP

   ii. Hands on training elsewhere

   iii. Good relationship with IXPs so that they have e-mail contact

   iv. Encourage engineers to attend regional and other local meetings

3. *Support:* In certain situations the underlying factor that may be inhibiting an IXP from getting started is one of trust or government understanding.

   i. *Lack of Trust:* This lack of trust may either come from a group of ISPs that don't trust one another or the organization that is attempting to start the IXP. Or the trust issue may simply stem from a lack of understanding of the whole concept of peering. In both cases neutral third party intervention can be beneficial.

   ii. *Government understanding:* Once again mainly due to lack of understanding, the local authorities may not be willing to authorise or financial aid an IXP. Letters or visits from IXPA representatives to these government officials may be of benefit in certain situations.

4. *Equipment:* In some circumstances this could be the largest financial investment that an IXP will have to make to initialize the IXP.

5. *Financial aid*: An IXP may be in need of actual cash to pay for certain required services, personnel, etc. or may ask for assistance in full or part payment of IXP related equipment or scholarships to attend regional operators conferences both locally and internationally.

With the 'Twinning program' an IXPA Member IXP would find, with help from its IXPA, a 'twin' IXP somewhere else in the world. This would either be a planned or already established IXP. The Member IXP can then do one or all of the following:

i. Offer an open communication channel between staff of the two IXPs, giving IXPs direct phone extensions and e-mail addresses so as they are able to make immediate contact with each other staff. Sometimes the 'twin' IXP is given access to restricted pages of the 'donor' IXP, possibly even 'intranet' access.

ii. Send one or more Member IXP representatives to the twin IXP to help out on particular issues and possibly give training.

iii. Full or part scholarships for IXPs to attend IXPA Forums or other IXP related meetings around the world. This scholarship would basically cover registrations fees, accommodation and flights.

iv. Pay IXPA Membership fees for the twin IXP

More details on the program can be found at https://www.euro-ix.net/ixps/support-ixps/twinning-program/

IXP Manager

IXP Manager is an IXP management tool developed by the Irish IXP INEX.[6] It is comprised of a web application with associated scripts and utilities which allows IXPs to manage customers, provision new connections and services and monitor traffic usage. It also has a self-contained customer portal allowing IXP members to view their IXP traffic statistics, peer to peer traffic and many other unique tools including a *My Peering Manager* and a *Route Server Prefix Analysis Tool*. Auto-provisioning features include configurations for route collectors, route servers, AS112 services, reverse DNS, graph collecting and more.

IXP Manager is free software: one can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation, version v2.0 of the License.

One of the goals of the IXP Manager development effort is to benefit the wider IXP community, and especially new and small IXPs looking to expand. The tool is continuously being adapted and improved following community feedback. Requests for new features are always considered, and INEX helps IXPs with installation of the package and training. Knowledge that then can be shared with others by a receiving IXP. Feedback is used to write improved documentation.

Because of this approach by now (how many?) IXPs use IXP Manager has their main IXP management tool.

IXP Manager is a complete and fully-featured application which will allow IXPs to manage their infrastructure and customers. Some of its many features include:

- customer management and provisioning
- switch and port discovery, assignment and graphing
- graphing of individual port usage, member and core LAGs, switch aggregates, infrastructure aggregates and IXP aggregates
- auto-generation of secure and proven configurations for as112 services, route collectors and route servers (Quagga, Bird and others)
- a customer portal which allows your members to:
    - view and monitor their own port's traffic (bps, pps, errors and discards)
    - view their individual peer to peer traffic
    - a unique tool called My Peering Manager allowing them to review who they are peered with and request new peerings
- support for IXP entities including data centres, racks, switches, switch ports, vlans, IP addresses, etc
- flexible member port configuration made up of one or more physical interfaces and one or more vlan interfaces (i.e. .1q tags supported, lags supported)
- reseller support
- skinable
- integration with third party apps such as Smokeping, Mailman, Nagios, IRR registries, RADIUS, TACACS, DNS

[6] https://www.inex.ie/ixp/index/about

IXP Manager is written in PHP using the Zend Framework, the Doctrine2 ORM and the Smarty templating engine. The project website and source code can be viewed at https://github.com/inex/IXP-Manager.

Operational Guidance for IXPs

An IXP is a single physical network infrastructure (typically an Ethernet local area network) to which many ISPs can connect. Any ISP that is connected to the IXP can exchange traffic with any of the other ISPs connected to the IXP, using a single physical connection to the IXP, thus overcoming the scalability problem of individual interconnections. Such peering practice is called "public peering" (as opposed to "private peering", where two ISPs have a direct physical interconnection as described above), and IXPs are often referred to as "peering points" or "public peering points".

By enabling traffic to take a shorter path to many ISP networks, an IXP can improve the efficiency of the Internet, resulting in a better service for the end user. Furthermore, since many networks have more than one connection to the Internet, it is not unusual to find several routes to the same network available at an IXP, thus providing a certain amount of redundancy.

IXPs are not, generally, involved in the peering agreements between connected ISPs; whom an ISP peers with, and the conditions of that peering, are a matter for the two ISPs involved. IXPs do however have requirements that an ISP must meet to connect to the IXP; also, since the physical network infrastructure is shared by all the connected ISPs, and activities of one ISP can potentially affect the other connected ISPs, all IXPs have rules for proper use of the IXP.

Euro-IX publishes operational guidance that aims to put in writing some of the technical practices which are widely accepted in the IXP world. They concern the setup and maintenance of an Exchange Point infrastructure as well as rules that ISPs who connect to an IXP should follow. It is important to note that this guidance does not set a standard, nor a set of normative principles: it is not intended as a baseline against which to measure an IXP, or to provide assurance that an IXP that follows this guidance is doing well. It is intended merely as advice for those that seek help, especially for those setting up an IXP wih no previous experience, derived from the experiences of a number of already established IXPs in their own local environment. In addition on the technical best practices related to Internet Exchange Points; commercial and political issues are not discussed.

Contributing to an enabling environment for IXPs

One of the challenges that IXPs face in some countries, especially in Latin America and Caribbean region, is that there are locally very few Autonomous Systems, in some case insufficient for creating IXP. The IXPs in Brazil have worked to encourage the creation and implementation of new Autonomous Systems; this action has resulted in a greater number of participants at their IXPs. Encouraging the creation and implementation of Autonomous Systems is part of the goal of LAC-IX.