IXP Manager
Introduction

AfIX, Mauritius
August 2019

Nick Hilliard

Chief Technical Officer
Internet Neutral Exchange Association
Company Limited by Guarantee
INEX Overview

• Founded in 1996
• 104 peering members
• ~320Gbit/s peak traffic
• Two infrastructures, 7 points of presence in Dublin
• Local IXP in Cork
IXP Manager Workshop

IXP Manager

- Full stack Management system for IXPs
- LAMP - Linux / Apache / PHP / MySQL
  - Any free unix clone
  - Any web server which supports PHP
  - MySQL
  - Some Perl where PHP doesn’t work well
- Open source software - GPLv2
- Available on [github.com/inex](https://github.com/inex)
IXP Manager Workshop

History

• Early experience with operating an IXP using Excel and txt files (didn’t work well)
• First CVS commits to IXP Manager v0.1 in May 2005
  • Based on in-house PHP framework written for another project in 2001/2002
  • In 2008, reduced route-server config complexity to a single tickbox per member
• Strategic realisation that INEX needed to invest in either people or software
• Hired Barry O’Donovan in 2008 to develop the application part-time
• Immediate decision to rewrite from scratch using Zend Framework
• IXP-Manager v1.0 deployed at INEX in July 2009
• Code de-INEX’d and released as IXP Manager v3.0 in Nov 2012.
Current Status

- Full-time developer, Yann Robin, hired in Dec 2016
- IXP Manager v5 completed in May 2019
  - Mostly an infrastructure update
  - Migration from Zend Framework to Laravel completed
  - Important but invisible work
- Now adding new features
- Development model is mostly linear
- In production at ~75 IXPs worldwide
Development Model

- Development structure can be found on www.ixpmanager.org
  - 3 year development plan, with sponsored funding model
  - Currently main sponsors are ISOC, Netflix, SwissIX and Facebook
  - Additional sponsorship: APNIC, ZA-INX, STH-IX, GR-IX, Interlan, NaMeX, NIX
  - Other funding from: LONAP, DE-CIX
- All copyright owned by INEX - Internet Neutral Exchange Association CLG
- Day-to-day development handled by Island Bridge Networks Ltd
- Annual project report is publicly available from the web site
- Full financial details provided annually to all sponsors
Functionality

• Administrative portal for managing an IXP
• Abstracted model of an IXP which includes:
  • Infrastructures, VLANs, locations, cabinets, patch panels, switches, switch ports, IP addresses, MAC addresses, IXP members, user accounts, route servers, IRRDB configuration
• Monitoring information includes per-member statistics (bits, packets, errors, discards), p2p traffic from sflow telemetry and Peering Matrix
• Integration with third party packages (Birdseye Looking Glass), BIRD, BIND, Mailman, smokeping, tac_plus4, Nagios, etc
• Member login system provides Peering Manager, route server prefix analysis tool, graph views
Dashboard

Overall Customer Numbers

<table>
<thead>
<tr>
<th>Customer Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full</td>
<td>104</td>
</tr>
<tr>
<td>Associate</td>
<td>16</td>
</tr>
<tr>
<td>Internal</td>
<td>2</td>
</tr>
<tr>
<td>Pro-bono</td>
<td>5</td>
</tr>
</tbody>
</table>

Customers by Location

<table>
<thead>
<tr>
<th>Location</th>
<th>Customers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equinix DB2 (Kilcarbery)</td>
<td>77</td>
</tr>
<tr>
<td>Equinix DB1 (Citywest)</td>
<td>58</td>
</tr>
<tr>
<td>Interxion DUB1</td>
<td>38</td>
</tr>
<tr>
<td>Cork Internet Exchange</td>
<td>19</td>
</tr>
<tr>
<td>Equinix DB3 (NWBP)</td>
<td>17</td>
</tr>
<tr>
<td>BT Citywest</td>
<td>12</td>
</tr>
<tr>
<td>Interxion DUB2</td>
<td>6</td>
</tr>
<tr>
<td>Vodafone Willsborough</td>
<td>1</td>
</tr>
</tbody>
</table>

INEX Aggregate Traffic

<table>
<thead>
<tr>
<th></th>
<th>Max</th>
<th>Average</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>In</td>
<td>317.028 Gbts</td>
<td>168.602 Gbts</td>
<td>92.110 Gbts</td>
</tr>
<tr>
<td>Out</td>
<td>317.028 Gbts</td>
<td>168.831 Gbts</td>
<td>92.137 Gbts</td>
</tr>
</tbody>
</table>

INEX LAN1 Aggregate Traffic

<table>
<thead>
<tr>
<th></th>
<th>Max</th>
<th>Average</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>In</td>
<td>254.673 Gbts</td>
<td>129.354 Gbts</td>
<td>75.702 Gbts</td>
</tr>
<tr>
<td>Out</td>
<td>255.106 Gbts</td>
<td>129.397 Gbts</td>
<td>75.730 Gbts</td>
</tr>
</tbody>
</table>
User Portal

- Graphs and Statistics, Cross-connects, Port configuration
- Peering Manager
  - Provides an interface to help IXP participants handle bilateral peering
  - System for sending templated emails
  - “De-mystification” mechanism to make it easier for IXP users
- Route server prefix analysis tool
  - Compares prefixes learned via BGP to route server to what members have included in their IRRDB policy
  - IXP Manager uses strict IRRDB filtering by default
- IXP administrators can temporarily switch privileges to any user
Your INEX - IXP Manager Dashboard

Aggregate Traffic Statistics

Recent Members
Our five most recent members are listed below. Have you arranged peering with them yet?

<table>
<thead>
<tr>
<th>Name</th>
<th>AS Number</th>
<th>Date Joined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sirius</td>
<td>AS60501</td>
<td>2019-06-24</td>
</tr>
<tr>
<td>Convergenze</td>
<td>AS39120</td>
<td>2019-03-29</td>
</tr>
<tr>
<td>Titania Networks Limited</td>
<td>AS56911</td>
<td>2019-02-04</td>
</tr>
<tr>
<td>RETN</td>
<td>AS9002</td>
<td>2019-01-28</td>
</tr>
<tr>
<td>SIPSYNERGY</td>
<td>AS51409</td>
<td>2018-10-12</td>
</tr>
</tbody>
</table>

No logo uploaded which means it is not currently displayed on our public website. Please click here to add one now.
IXP Port Configuration

- Supports all the usual things you’d expect to see at an IXP
- Enables port configuration using an abstracted model
  - Physical interfaces: what you plug a cross-connect into
  - VLAN interfaces: what the customer sees
  - Virtual interfaces: attaches VLAN interfaces to physical interfaces
Physical Interface Settings

- **Switch**: sw1-nwb1-1
- **Switch Port**: Ethernet1 (Peering)
- **Status**: Connected
- **Speed**: 1 Gbps
- **Duplex**: full
- **Auto-Negotiation Enabled**: ON
- **Monitor Index**: 1
- **Notes**:

Save Changes | Cancel | Help
### General VLAN Settings

<table>
<thead>
<tr>
<th>VLAN</th>
<th>Max BGP Prefixes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peering VLAN #1</td>
<td>0</td>
</tr>
</tbody>
</table>

- Multicast Enabled: Off
- Busy host: Off
- IPv6 Enabled: On
- IPv4 Enabled: On

### IPv6 Details

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPv6 Address</td>
<td>2001:718:18::6</td>
</tr>
<tr>
<td>IPv6 Hostname</td>
<td>as112-vl10.inex.ie</td>
</tr>
<tr>
<td>IPv6 BGP MD5 Secret</td>
<td></td>
</tr>
</tbody>
</table>

- IPv6 Ping Allowed / Possible: Off
- IPv6 Monitor Route Collector BGP: On

### IPv4 Details

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPv4 Address</td>
<td>185.6.36.6</td>
</tr>
<tr>
<td>IPv4 Hostname</td>
<td>as112-vl10.inex.ie</td>
</tr>
<tr>
<td>IPv4 BGP MD5 Secret</td>
<td></td>
</tr>
</tbody>
</table>

- IPv4 Ping Allowed / Possible: On
- IPv4 Monitor Route Collector BGP: On

---

The content of this presentation may be used or redistributed under the terms of the Creative Commons Attribution-ShareAlike 4.0 License.
The content of this presentation may be used or redistributed under the terms of the Creative Commons Attribution-ShareAlike 4.0 License.
MAC Addresses

- Static MAC addresses
  - Allows the IXP operator to configure a list of MAC addresses per VLAN interface
  - This information is exportable and can be used to configure switches
- Dynamic MAC addresses
  - A database of MAC addresses pulled from the IXP switches via SNMP
  - Used for Sflow integration and the Peering Matrix
Patch Panels

- Everyone has difficulty with patch panels and cross-connects
  - … including data centres
- Most people manage their cross-connect deployments using
  - Text files
  - Spreadsheet
  - Wiki
  - Post-it notes
<table>
<thead>
<tr>
<th>Name</th>
<th>Rack</th>
<th>Colocation</th>
<th>Type</th>
<th>Ports Available</th>
<th>Installation Date</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUB2.17.R01.01</td>
<td>INEX-PWT2-1</td>
<td>I.E.DUB2.19.DDF1.U01</td>
<td>UTP / RJ45</td>
<td>22 / 24</td>
<td>2017-03-27</td>
<td></td>
</tr>
<tr>
<td>DUB2.17.R01.01.U41</td>
<td>INEX-PWT2-1</td>
<td>I.E.DUB2.19.ODFB.U77</td>
<td>SMF / SC</td>
<td>5 / 6 10 / 12</td>
<td>2017-03-27</td>
<td></td>
</tr>
<tr>
<td>DUB2.17.R01.01.U43</td>
<td>INEX-PWT2-1</td>
<td>I.E.DUB2.19.ODFA.U78</td>
<td>SMF / SC</td>
<td>3 / 6 0 / 12</td>
<td>2017-03-27</td>
<td></td>
</tr>
<tr>
<td>I.E.DUB1.2B.R03.01.U46</td>
<td>INEX-PWT1-1</td>
<td>I.E.DUB1.2B.R03.01.U46</td>
<td>SMF / SC</td>
<td>0 / 12 0 / 24</td>
<td>2013-07-01</td>
<td></td>
</tr>
<tr>
<td>I.E.DUB1.2B.R03.01.U48</td>
<td>INEX-PWT1-1</td>
<td>I.E.DUB1.2B.R03.01.U48</td>
<td>UTP / RJ45</td>
<td>15 / 24</td>
<td>2013-07-01</td>
<td></td>
</tr>
<tr>
<td>L17-U47-C1</td>
<td>INEX-CIX-1</td>
<td>L17-U47-C1</td>
<td>SMF / LC</td>
<td>0 / 12 0 / 24</td>
<td>2016-04-01</td>
<td></td>
</tr>
</tbody>
</table>
Patch Panels

- IXP Manager’s patch panel support includes:
  - Fibre, UTP, different termination types
  - Simplex / duplex connections
  - Live-links to IXP port configurations
  - Simplex / duplex connections
  - Cross-connect history
  - Customer-visible and private notes
  - LOAs via email (PDF) with authentication via live-links
- Doesn’t support circuits or linking cross-connects together
## Ports for PP:

<table>
<thead>
<tr>
<th>Name</th>
<th>Description / Switch / Port</th>
<th>Customer</th>
<th>Colocation Ref</th>
<th>Flags</th>
<th>Assigned at</th>
<th>State</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1/F2 (1)</td>
<td>Link to Vodafone Clonsnaugh</td>
<td>INEX</td>
<td>PP:00000000</td>
<td>INT-S</td>
<td>2013-04-17</td>
<td>Connected</td>
<td>Action ↓</td>
</tr>
<tr>
<td>F3/F4 (2)</td>
<td>swi1-cwt1-1 :: Ethernet8</td>
<td>INEX</td>
<td>PP:00000000</td>
<td>N-</td>
<td>2013-02-18</td>
<td>Connected</td>
<td>Action ↓</td>
</tr>
<tr>
<td>F5/F6 (3)</td>
<td>swi1-cwt1-1 :: Ethernet9</td>
<td>INEX</td>
<td>PP:00000000</td>
<td>N+</td>
<td>2013-03-29</td>
<td>Connected</td>
<td>Action ↓</td>
</tr>
<tr>
<td>F7/F8 (4)</td>
<td>Core: Eunetworks Metro KCP1-CWT1 (PP:00000000)</td>
<td>INEX</td>
<td>PP:00000000</td>
<td>INT-N</td>
<td>2017-05-08</td>
<td>Connected</td>
<td>Action ↓</td>
</tr>
<tr>
<td>F9/F10 (5)</td>
<td>swi1-cwt1-1 :: Ethernet11</td>
<td>INEX</td>
<td>PP:00000000</td>
<td></td>
<td>2009-11-20</td>
<td>Connected</td>
<td>Action ↓</td>
</tr>
<tr>
<td>F11/F12 (6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2014-10-10</td>
<td>Connected</td>
<td>Action ↓</td>
</tr>
</tbody>
</table>

Showing 1 to 6 of 6 entries
IXP Resellers

- Many IXPs introducing reseller programs
- A “customer” can be both a reseller and an IXP participant
- Supported for fan-out ports
  - Resellers see their fanout ports
  - Resold members see their peering ports
  - Requires either physical fanout or else sub-interface fanout
- No reduction in functionality for resold members
- MRTG / P2P graphing all compatible
- Skin API documented at: http://git.io/he2RmQ
Graphing

- Three primary graphing interfaces available
- **MRTG**
  - Used for bits, packets, errors, discards
  - Simple but functional - allows abstraction of the switch interface name
  - Potential scalability issues on larger IXPs
- **Smokeping**
  - Measures RTT to all routers on the IXP
  - Mostly measures how busy the remote control plane is
  - Invaluable for debugging connectivity problems
Graphing

• Sflow
  • Custom-built interface to process sflow flow records
  • Used for peer-to-peer graphs and BGP peering matrix
  • Peer-to-peer are considered invaluable by IXP participants
  • Functionality depends on sflow support on the IXP switches
    • Hardware support for sflow is mixed but improving
    • Native support in all recent Broadcom and Mellanox chipsets
    • Some vendors don’t make this work properly at the user level
  • FreeBSD UFS found to work better than Linux ext3 for RRD store
Route Servers

- Critical for all IXPs due to overhead of maintaining full-mesh bilateral peering
- Generates secure-by-default configurations
  - Strict prefix and ASN filtering enabled using IRRDB info
    - Can be disabled per customer. This is a really bad idea. Don’t disable it.
  - MD5 and per-protocol max prefixes
- Default templating skin doesn’t support RPKI
  - RPKI on route servers is more subtle than it looks
- Implementation is designed to discourage manual hacks (this is a feature)
IRRDBs

- Used for Route server configuration generation
- Allows admin-defined IRRDB evaluation policies
  - Custom IRRDB policy can be configured per member
- Building complex prefix lists can cause performance problems
  - phase 1: pull IRRDB route objects to local DB using bgpq3
  - phase 2: build prefix lists from local DB
- Won’t work with Quagga for some ASNs
- Needs PHP-DS add-on module
Templating and APIs

- Each IXP shares a common set of requirements but also has its own needs
- IXP Manager supports Skins and an API-based data exporter
- Skins
  - High complexity level
  - Written with PHP and Smarty
  - Intended for complex functionality, e.g. Route Server config
  - All functionality bundled with IXP Manager distribution
  - Can be extended on local installations, but care needed for future portability
  - Used for almost everything from User-Interface to “Routers” to graphing
Skin Example: Routers

- An IXP Manager Router is an abstraction of a device which speaks BGP
  - Route server, route collector, AS112
  - Trivially easy to create router instances for this functionality (INEX has 30)
  - Integrates fully with Birds Eye Looking Glass
  - Current skins support only BIRD
  - Previous versions of IXP Manager also supported Quagga
    - Difficult to manage this because it lacks atomic config rewrite + reload
- Other options available:
  - OpenBGPD, GoBGP
<table>
<thead>
<tr>
<th><strong>Handle</strong></th>
<th>rc1q-lan1-ipv4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vlan</strong></td>
<td>Quarantine VLAN - LAN1</td>
</tr>
<tr>
<td><strong>Protocol</strong></td>
<td>IPv4</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>Route Collector</td>
</tr>
<tr>
<td><strong>Name</strong></td>
<td>INEX LAN1 - Quarantine Route Collector - IPv4</td>
</tr>
<tr>
<td><strong>ShortName</strong></td>
<td>RC1 - LAN1 - IPv4</td>
</tr>
<tr>
<td><strong>Router ID</strong></td>
<td>185.6.36.126</td>
</tr>
<tr>
<td><strong>Peering IP</strong></td>
<td>185.6.36.126</td>
</tr>
<tr>
<td><strong>ASN</strong></td>
<td>2128</td>
</tr>
<tr>
<td><strong>Software</strong></td>
<td>Bird</td>
</tr>
<tr>
<td><strong>Management Host</strong></td>
<td>10.39.5.214</td>
</tr>
<tr>
<td><strong>API Type</strong></td>
<td>Birdseye</td>
</tr>
<tr>
<td><strong>API Endpoint</strong></td>
<td><a href="http://rc1q-lan1-ipv4.mgmt.inex.ie/api">http://rc1q-lan1-ipv4.mgmt.inex.ie/api</a></td>
</tr>
<tr>
<td><strong>LG Access Privileges</strong></td>
<td>PUBLIC</td>
</tr>
</tbody>
</table>
Templating and APIs

- **API Data Exporters**
  - exports core database information in abstracted format
  - Supports JSON and YAML output
  - This can be fed into your favourite templating system
    - e.g. INEX uses Smarty and Jinja2/SaltStack
    - No issues with using your own favourite templating mechanism
  - Future portability assured with REST endpoint stability
  - INEX is likely to move some “core” functionality to this mechanism
  - Documentation is in progress for these APIs
  - IX-F / Euro-IX JSON data export schema works out of the box
**Summary**

- Full stack IXP administration application
- Supports most things that IXPs need to do
- Suitable for most IXPs
- In active development with sponsorship from many organisations
- Community Supported
- Join mailing list at: [www.ixpmanager.org/support.php](http://www.ixpmanager.org/support.php)
- It will make your life easier
Thanks!