HolistIX: Software & Intend Based Networking within IXPs

Marc Bruyere & Christoff Visser @ IIJ Lab
How IXPs can minimize Effort, Cost and Risk?
IXP’s “Costs and Efforts” is multi-dimensional

- Administrative
- Commercial
- Engineering
- Technical
- Hardware
- Infrastructure
IXP’s “Costs and Efforts” is multi-dimensional

- Administrative
- Commercial
- Engineering
- Technical
- Hardware
- Infrastructure
IXP’s “Costs and Efforts”
is multi-dimensional

Administrative Commercial

Engineering Technical

Hardware Infrastructure
IXP’s “Costs and Efforts” is multi-dimensional

- Administrative Commercial
- Engineering Technical
- Hardware Infrastructure
Question: The effort and cost for connecting a new IXP member?
# IXP’s “Costs”

Cost level to connect a new member

<table>
<thead>
<tr>
<th></th>
<th>Request To connect</th>
<th>Provisioning</th>
<th>Setup</th>
<th>Validation</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Administration</strong></td>
<td>Medium</td>
<td>Low</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><strong>Commercial</strong></td>
<td>Medium</td>
<td>Low</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><strong>Engineering</strong></td>
<td>Low to none</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>Medium to high</td>
</tr>
<tr>
<td><strong>Technical</strong></td>
<td>Low to none</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>Medium to high</td>
</tr>
<tr>
<td><strong>Hardware</strong></td>
<td>None</td>
<td>Medium to high</td>
<td>Medium</td>
<td>Low to none</td>
<td>Low to none</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td>None</td>
<td>Medium to high</td>
<td>Medium</td>
<td>Low to none</td>
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### IXP’s “Costs”

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</table>
**IXP’s “Costs”**

**Our Reduction Goals**

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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Engineering</strong></td>
<td>Low to none</td>
<td>✔️ Medium</td>
<td>✔️ High</td>
<td>✔️ High</td>
<td>✔️ Medium to high</td>
</tr>
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<td><strong>Technical</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Hardware</strong></td>
<td>None</td>
<td>Medium to high</td>
<td>Medium</td>
<td>Low to none</td>
<td>Low to none</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Question: Cost to change the infrastructure architecture?
# IXP’s “Costs”

## IXP infrastructure cost level

<table>
<thead>
<tr>
<th>Admin</th>
<th>Design</th>
<th>Stagging</th>
<th>Validation Pre production</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technical Human cost</th>
<th>Design</th>
<th>Stagging</th>
<th>Validation Pre production</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Medium to High</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical Equipment</th>
<th>Design</th>
<th>Stagging</th>
<th>Validation Pre production</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>None</td>
</tr>
</tbody>
</table>
IXP’s “Costs”
IXP infrastructure cost level

**Admin**
- Design: Medium
- Stagging: None
- Validation Pre production: None
- Maintenance: None

**Technical Human cost**
- Design: High
- Stagging: High
- Validation Pre production: High
- Maintenance: Medium to High

**Physical Equipement**
- Design: High
- Stagging: Medium
- Validation Pre production: High
- Maintenance: None
## IXP’s “Costs”

### Reduction goals

<table>
<thead>
<tr>
<th></th>
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<td>Admin</td>
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<td></td>
<td>None</td>
</tr>
<tr>
<td>Technical Human cost</td>
<td>✔️ High</td>
<td>✔️ High</td>
<td>✔️ High</td>
<td>Medium to High</td>
</tr>
<tr>
<td>Physical Equipement</td>
<td>✔️ High</td>
<td>✔️ Medium</td>
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<td>None</td>
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</tbody>
</table>
HolistIX:
Full Automation Stack
HolistIX: IXP-Manager Add-on
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HolistIX: IXP-Manager Add-on
• Free & Open Source Software Platform for IXPs
• Teaches and implements best practice
• MANRS Compliant
• Full stack management platform
• Do more with less
• Route server configuration
Question: What bring HolistIX?
HolistIX

- IXP Manager
- Miru
HolistIX

- IXP Manager
- Miru

Plan

Verify

- Athos
HolistIX

Plan
- IXP Manager
- Miru

Verify
- Athos

Deploy
- Cerberus
HolistIX

- Introduce automation from the top down for IXPs
  - Plan > Verify > Deploy
- Based on the Software Designed Network Umbrella switching fabric.
  - Change broadcast packets to unicast ones
  - No more quarantine time
- Not all vendor switch can support Umbrella
Miru: Provisioning & Planning
### Overall Member Numbers

<table>
<thead>
<tr>
<th>Member Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal</td>
<td>1</td>
</tr>
<tr>
<td>Full</td>
<td>20</td>
</tr>
</tbody>
</table>

### Members by VLAN

We count full and pro-bono members with at least one connected physical interface.

<table>
<thead>
<tr>
<th>VLAN</th>
<th>Members</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peerin_VLAN</td>
<td>25</td>
<td>100%</td>
</tr>
<tr>
<td>NSPPK3_VLAN</td>
<td>3</td>
<td>12%</td>
</tr>
</tbody>
</table>

### Members by Location

<table>
<thead>
<tr>
<th>Location</th>
<th>Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>KDDI Osaka</td>
<td>20</td>
</tr>
<tr>
<td>NTTCom Osaka</td>
<td>8</td>
</tr>
<tr>
<td>NTTdata Osaka</td>
<td>1</td>
</tr>
</tbody>
</table>

### Member Ports by Location

<table>
<thead>
<tr>
<th>Location</th>
<th>100 Mbits</th>
<th>1 Gbits</th>
<th>10 Gbits</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTTCom Osaka</td>
<td>0</td>
<td>6</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>NTTdata Osaka</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>KDDI Osaka</td>
<td>5</td>
<td>11</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5</strong></td>
<td><strong>17</strong></td>
<td><strong>7</strong></td>
<td><strong>29</strong></td>
</tr>
</tbody>
</table>

### Virtual Interfaces / List

<table>
<thead>
<tr>
<th>Member</th>
<th>Facility</th>
<th>Switch</th>
<th>Port(s)</th>
<th>Speed</th>
<th>Raw Speed</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acme Internet Access</td>
<td>Facility 1</td>
<td>s1</td>
<td>port1.0.1</td>
<td>1 Gbits</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Alpha Corp</td>
<td>Facility 1</td>
<td>s1</td>
<td>port1.0.2</td>
<td>1 Gbits</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Charlie Internet Access</td>
<td>Facility 1</td>
<td>s1</td>
<td>port1.0.3</td>
<td>1 Gbits</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Delta Internet Access</td>
<td>Facility 1</td>
<td>s2</td>
<td>port1.0.1</td>
<td>1 Gbits</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Echo Internet Access</td>
<td>Facility 1</td>
<td>s2</td>
<td>port1.0.2</td>
<td>1 Gbits</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Foxtrot Internet</td>
<td>Facility 1</td>
<td>s2</td>
<td>port1.0.3</td>
<td>1 Gbits</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Golf Electric</td>
<td>Facility 1</td>
<td>s3</td>
<td>port1.0.1</td>
<td>1 Gbits</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Customer</td>
<td>Interface(s)</td>
<td>VLAN</td>
<td>IPv4</td>
<td>IPv6</td>
<td>MAC Address</td>
<td>Manufacturer</td>
</tr>
<tr>
<td>------------------------</td>
<td>--------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Acme Internet Access</td>
<td>s1::port1.0.1</td>
<td>peering</td>
<td>10.0.0.1</td>
<td>fd00::1</td>
<td>000000000001</td>
<td>Unknown</td>
</tr>
<tr>
<td>Acme Internet Access</td>
<td>s1::port1.0.1</td>
<td>Vlan2</td>
<td>10.0.1.1</td>
<td>2001:db8::1</td>
<td>0000000000021</td>
<td>Unknown</td>
</tr>
<tr>
<td>Acme Internet Access</td>
<td>s1::port1.0.1</td>
<td>vlan3</td>
<td>10.0.2.1</td>
<td>2001:db8:2::</td>
<td>0000000000022</td>
<td>Unknown</td>
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<tr>
<td>Acme Internet Access</td>
<td>s1::port1.0.1</td>
<td>vlan4</td>
<td>10.0.3.1</td>
<td>2001:db8:3::</td>
<td>0000000000023</td>
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</tr>
<tr>
<td>Alpha Corp</td>
<td>s1::port1.0.2</td>
<td>peering</td>
<td>10.0.0.2</td>
<td>fd00::2</td>
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<tr>
<td>Charlie Internet Access</td>
<td>s1::port1.0.3</td>
<td>peering</td>
<td>10.0.0.3</td>
<td>fd00::3</td>
<td>000000000003</td>
<td>Unknown</td>
</tr>
<tr>
<td>Delta Internet Access</td>
<td>s2::port1.0.1</td>
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<td>fd00::4</td>
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</tr>
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<td>Echo Internet Access</td>
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<td>peering</td>
<td>10.0.0.5</td>
<td>fd00::5</td>
<td>000000000005</td>
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<tr>
<td>Foxtrot Internet</td>
<td>s2::port1.0.3</td>
<td>peering</td>
<td>10.0.0.6</td>
<td>fd00::6</td>
<td>000000000006</td>
<td>Unknown</td>
</tr>
<tr>
<td>Golf</td>
<td>s3::port1.0.1</td>
<td>peering</td>
<td>10.0.0.7</td>
<td>fd00::7</td>
<td>000000000007</td>
<td>Unknown</td>
</tr>
</tbody>
</table>
Miru
Miru

- Visual network planning
- Drag and drop diagramming
- Acts as the network's source of truth
- Generates network configurations
- Emulate and test your network before deploying it
- Deploy with a single click
Athos: No more risk with verification
Athos

- Emulates configured network
- Test reachability between members
- Validates network redundancy

Athos output

Echo Internet Access -> Acme Internet Access Alpha Corp Charlie Internet Access Delta Internet Access Foxtrot internet golf IJ SCIX test VEON Group
Foxtrot internet -> Acme Internet Access Alpha Corp Charlie Internet Access Delta Internet Access Echo Internet Access Golf IJ SCIX test VEON Group
golf -> Acme Internet Access Alpha Corp Charlie Internet Access Delta Internet Access Echo Internet Access Foxtrot internet IJ SCIX test VEON Group
IJU -> Acme Internet Access Alpha Corp Charlie Internet Access Delta Internet Access Echo Internet Access Foxtrot internet golf IJ SCIX test VEON Group
SCIX -> Acme Internet Access Alpha Corp Charlie Internet Access Delta Internet Access Echo Internet Access Foxtrot internet golf IJ test VEON Group
test -> Acme Internet Access Alpha Corp Charlie Internet Access Delta Internet Access Echo Internet Access Foxtrot internet golf IJ SCIX VEON Group
VEON Group -> Acme Internet Access Alpha Corp Charlie Internet Access Delta Internet Access Echo Internet Access Foxtrot internet golf IJ SCIX test
*** Results: 0% dropped (110/110 received)
*** Stopping 1 controllers
faucet
*** Stopping 16 links
............... 
*** Stopping 6 switches
c101 c102 s1 s2 s3 s4
*** Stopping 11 hosts
h1 h2 h3 h4 h5 h6 h7 h8 h9 h10 h11
*** Done
Success with no packet loss

- OpenFlow support on edge Switches
- P4 support for core switches
- Docker support
Cerberus: Make it work & maintained
Cerberus

- API support to deploy from IXP Manager
- Rollback and fail state integration
- Transfer network config generation to the controller
Resume

- Automated deployment
- No more manual configuration when making changes
- Push on Green
- Made for SDN Switching Fabric
Show time:
Real hardware demo
Member A:

Member B:

Member C:

Member D:

Member E:

Member F:

Member G:

Member H:

Member I:

Member J:

Member K:

Member L:

Member M:

Member N:

Member O:

Member P:

Member Q:

Member R:

Member S:

Member T:

Member U:

Member V:

Member W:

Member X:

Member Y:

Member Z:
Deployments and collaboration

• Deployed at the Toulouse IX
• DIX-IE -> PIX-IE WIDE Project IXP
• France-IX HolistIX testbed
• Discussion with CIVIX and KINIX
Sustaining the peering community

• Looking for testing and demo with IXPs and ISPs
• Aim to build a long-term initiative
• Aiming to publish Academic papers as: https://ieeexplore.ieee.org/document/9615540
Questions?

Links and Contact

https://holistix.iijlab.net

contact@holistix.email

@IxHolist