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Anatomy of a Large European IXP

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Abstract

- Target: peering links at single IXP >> peer-peer type in entire Internet.
- Examine: IXP’s eco-system and diversity of networks.
IXP

- A physical network infrastructure operated by single entity with the purpose to facilitate the exchange of the Internet traffic between Autonomous Systems
IXP Overview

- Private; Public
- large == good
- layer 2 switching
IP packet forwarded in ASes

- Traffic Increased!
- ASes is in tier-2.

**Table 1: Overview of IXPs sFlow dataset.**

<table>
<thead>
<tr>
<th></th>
<th>Apr 25</th>
<th>May 1</th>
<th>Aug 22</th>
<th>Aug 28</th>
<th>Oct 10</th>
<th>Oct 16</th>
<th>Nov 28</th>
<th>Dec 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identified member ASes</td>
<td>358</td>
<td>375</td>
<td>383</td>
<td>408</td>
<td>416</td>
<td>424</td>
<td>432</td>
<td>440</td>
</tr>
<tr>
<td>Router IPs</td>
<td>426</td>
<td>448</td>
<td>455</td>
<td>474</td>
<td>474</td>
<td>474</td>
<td>474</td>
<td>474</td>
</tr>
<tr>
<td>MAC addresses</td>
<td>428</td>
<td>448</td>
<td>458</td>
<td>474</td>
<td>474</td>
<td>474</td>
<td>474</td>
<td>474</td>
</tr>
<tr>
<td>Tier-1</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Tier-2</td>
<td>281</td>
<td>292</td>
<td>297</td>
<td>306</td>
<td>306</td>
<td>306</td>
<td>306</td>
<td>306</td>
</tr>
<tr>
<td>Leaf</td>
<td>64</td>
<td>70</td>
<td>73</td>
<td>77</td>
<td>77</td>
<td>77</td>
<td>77</td>
<td>77</td>
</tr>
<tr>
<td>Countries of member ASes</td>
<td>43</td>
<td>44</td>
<td>45</td>
<td>47</td>
<td>47</td>
<td>47</td>
<td>47</td>
<td>47</td>
</tr>
<tr>
<td>Continents of member ASes</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Average packet rate (Mpps)</td>
<td>142</td>
<td>150</td>
<td>166</td>
<td>174</td>
<td>174</td>
<td>174</td>
<td>174</td>
<td>174</td>
</tr>
<tr>
<td>Average bandwidth (Gbps)</td>
<td>838</td>
<td>863</td>
<td>954</td>
<td>992</td>
<td>992</td>
<td>992</td>
<td>992</td>
<td>992</td>
</tr>
<tr>
<td>Daily avg volume (PB)</td>
<td>9.0</td>
<td>9.3</td>
<td>10.3</td>
<td>10.3</td>
<td>10.3</td>
<td>10.3</td>
<td>10.3</td>
<td>10.3</td>
</tr>
</tbody>
</table>
Traffic Statistics

- Tier-2 were responsible for most traffic.
- HTTP accounted around 50%, then video, file sharing.
IXP centric view of AS-level connection

- Visible P-P links seen from IXP-external data
- unique visible P-P link
- 70% P-P link is invisible

Figure 2: Peering links and visibility in control/data plane (normalized by number of detected P-P links).

Table 2: Overview of routing and looking glass datasets for November. The numbers show P-P links.

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Unique LGs / ASN</th>
<th>Visible links</th>
<th>only in this dataset</th>
</tr>
</thead>
<tbody>
<tr>
<td>RV</td>
<td>78</td>
<td>5,336</td>
<td>1,084</td>
</tr>
<tr>
<td>RIPE</td>
<td>319</td>
<td>10,913</td>
<td>5,460</td>
</tr>
<tr>
<td>NP</td>
<td>723</td>
<td>3,419</td>
<td>684</td>
</tr>
<tr>
<td>RV+RIPE+NP</td>
<td>997</td>
<td>13,051</td>
<td>10,472</td>
</tr>
<tr>
<td>LG</td>
<td>821 / 148</td>
<td>4,892</td>
<td>2,313</td>
</tr>
<tr>
<td>RV+RIPE+NP+LG</td>
<td>1,070</td>
<td>15,364</td>
<td>15,364</td>
</tr>
</tbody>
</table>

RV: route view
RIPE: regional internet registries
NP: non-public
LG: looking glass
Member diversity — number of peers

- Most members have a large number of peers.

(b) Scatter-plot of num. of peers per member.
Fraction of web traffic

- Individual ASes differs significant.
- Almost a uniform distribution
- similar overall application mix

(c) Fractions of web-traffic across members.
Geographic distances of IP end point to IXP

- IP source address to IXP
- HCDN has largest fraction. (Miss match/serve for remote address).
3D projection based on top member ASes by byte sent

- conventional tier classification is little help for understanding the Internet ecosystem locally
Daily pattern—top 10 tier-2 member

- Pronounced time of day effects
- Top 10 tier-2 responsible for 33% of traffic
- Some ASes fully utilize their capacity

(a) Daily pattern of top-10 tier-2 members.
Structural properties of traffic matrix

- Using SVD to understand traffic matrix rank
- Energy in first k singular values
- 22 values suffice for 95% of the energy
- Even smaller k for application specific matrix
Some observations

- Even tier 1 are members of IXP and do public peering links
- IXP is well wide used and most links has traffic
- IXP is more and more like a ASes
Conclusion

- reveal diverse IXP eco-system members, business types, connectivity, traffic
- Large IXP supports rich peering fabric
- Implication for studies of AS-level Internet