Uncovering Remote Peering Interconnections at IXPs

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Benefits of Internet eXchange Points*

- Keeps local Internet traffic within a local infrastructure, and reduces costs associated with traffic exchange between networks.
- Builds local Internet community and develops human technical capacity – better net management skills and routing.
- Improves the quality of Internet services and drive demand in by reducing delay and improving end-user experience.
- Convenient hub for attracting hosting key Internet infrastructures within countries – content is key and confidence builds in local infra when delivery is consistent and reliable.
- Catalyst for overall Internet development.

Pressure for Diverse Peering

- Volume of traffic is constantly increasing
  - CDNs, Cloud, IOT
- Pressure on ASes for denser and more diverse peering connectivity
- A fundamental shift in peering practices is required
Peer Remotely?

- Connect to IXP peering fabric without collocating a router at an IXP facility
  - Cut equipment, deployment, operational costs
- Connect to multiple IXPs through a single router
Yes, but...

Remote Peering cancels out many IXP benefits

1. Introduces third parties
   - Opaqueness
   - Harder to monitor and debug
2. Reduces resilience and reliability
3. Increases latency
Remote Peering over IXPs

- **Remote Peering** is when a network peers at an IXP:
  1. without having physical presence in the IXP’s infrastructure
  2. and/or through resellers
OUR GOAL
“What goes on beyond that cable?”

- Transparency
  - Identify remote/local peers
  - For both IXP operators and customers point of view

- Features of Remote Peering
  - Study if/how remote peers’ characteristics can differentiate from local peers
State-of-the-art
RTT-based Remote Peering Inference

- Detect remote peers based on RTT measurements
- Execute ping from Looking Glass inside the IXP to the peering interfaces

**RTTs > 10 ms** indicate remote peers
- Conservative threshold for local / regional IXPs

What Ground-Truth Says:

- **Regional IXPs:** 40% of remote peers have < 10ms RTT
- **18%** of remote peers have < 1ms RTT

- **Wide-area IXPs:** 87% of facility pairs have > 10ms median RTT (NET-IX)
- **~14%** of IXPs are wide-area
Our Methodology - How it works

- We propose a ‘first-principles’ approach to infer remote and local peers

- Design aspects:
  1. Port Capacity
     - Low port capacities indicate that networks peer remotely at an IXP
  2. Ping RTT Measurements
     - RTT values provide evidence for how far (from the IXP) a peer is located
  3. Colocation Facilities
     - An AS can be a local peer of an IXP if they are colocated in the same facility (no reseller involved)
  4. Multi-IXP Routers
     - An AS may connect to multiple IXPs through the same border router
  5. Private Connectivity over Facilities
     - Private interconnections can be established within the same IXP-hosting facility
Algorithm Overview – 4 Modules

1. Find reseller customers
2. Infer the distance between IXP member and Facility
3. Identify multi-IXP routers
4. Localize at the Facility level the private connectivity

- Port capacities from IXP websites and PeeringDB
- RTTs from VPs within IXPs to IXP IPs + Facility information
- Traceroutes + Facility Information
- Traceroutes + AS-to-Facility mappings
## Does it work?

<table>
<thead>
<tr>
<th>Inference Module</th>
<th>Coverage</th>
<th>Precision</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Port Capacity</td>
<td>11%</td>
<td>96%</td>
<td></td>
</tr>
<tr>
<td>2) RTT (<em>min</em>) + Colocation Info</td>
<td>76%</td>
<td>99.6%</td>
<td>94%</td>
</tr>
<tr>
<td>3) Multi-IXP</td>
<td>53%</td>
<td>97.5%</td>
<td>93%</td>
</tr>
<tr>
<td>4) Private Links</td>
<td>49%</td>
<td>95%</td>
<td>85%</td>
</tr>
<tr>
<td>Combined</td>
<td>93%</td>
<td>95%</td>
<td>94.5%</td>
</tr>
</tbody>
</table>
Remote Peering in the Wild
Contribution per Inference Module

For the top-30 IXPs (7-9 April, 2018):

- **10%** of the inferences can be made using only port capacity information
- **RTT+Colo** and **MultiIXP** modules account for the majority of the inferences
- **25%** of the multi-IXP routers connect to more than 10 IXPs
We also found:

- **1 / 3** of members peers remotely with the IXP
- **90%** of IXPs have at least **10%** of their peers as remote
- Large IXPs (e.g. AMS-IX, DE-CIX, France-IX) have **~40%** of their peers as remote
1. Daily RTT measurements from VPs in 5 IXPs between 2017/07 – 2018/10
   - LINX, LONAP, HKIX, THINX, UAIX

2. Also confirmed from annual reports of AMS-IX, DE-CIX, France-IX
   - Remote peers grow \textit{twice} as much compared with local peers
   - Remote peers exhibit higher join (x2) and departure (x1.25) rates
   - 18 remote peers switched to local
Other Features of IXP members

- Aggregate traffic levels
- Customer cone size
RP Routing Implications

- Interested in circuitous paths between ASes with >1 common IXP

- Traceroutes from remote peers (381 members) to any other IXP member (781 in total) in DE-CIX Frankfurt

- 66% of the cases include the closest IXP to the remote peer

- 34% of the cases do not comply with an expected *hot potato* exit strategy
Remote/Local peering visualization
Filtering remote/local peers in the IXP and Facility level
REST API
Publicly available soon

DEMO: http://remote-ixp-peering.net
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Conclusions

- New methodology to accurately infer peers connected to IXPs through remote peering
  - Increase transparency of peering ecosystem
  - Illuminate peering trends and practices

- Remote Peering becomes popular practice and is almost ubiquitous
  - Saturation of local markets pushes IXPs to expand to new markets

- A publicly accessible web portal with:
  - Monthly snapshots with remote and local peering inferences
  - Visualization of geographical footprints of IXPs and their members

Reference – Accepted Paper in IMC Conference, Boston, 2018
Future Work

- Longitudinal Study
  - An extensive analysis including more IXPs back in time
  - Investigate if remote peering is an actual trend
  - It can benefit IXPs to overcome local saturation

- Traffic Analysis
  - Interpretation of traffic levels of remote and local IXP peering interconnections
Thank You

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