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Uncovering Remote Peering Interconnections at IXPs

Joint work with:

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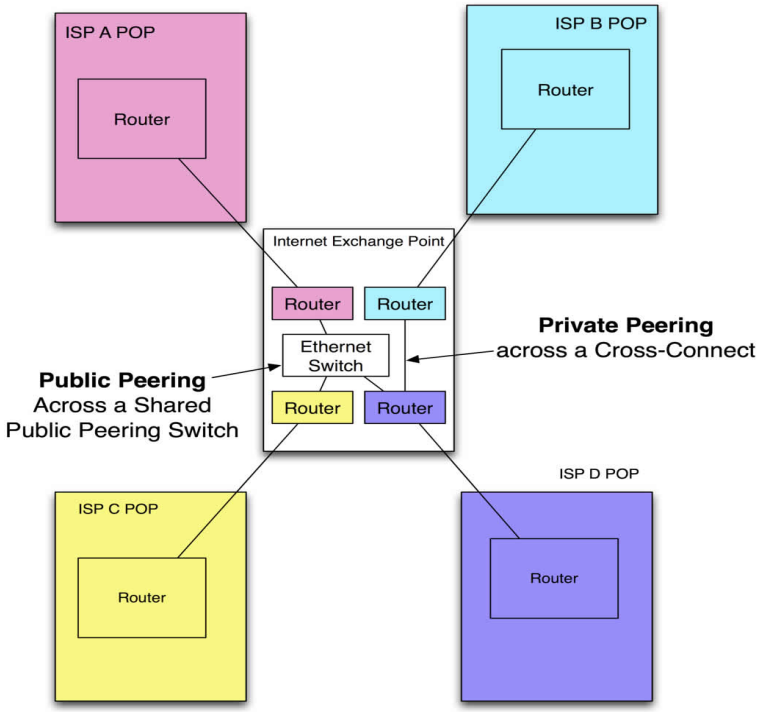
What is an Internet eXchange Point (IXP)?

- A layer-2 infrastructure to exchange Internet traffic
- Provides direct interconnection among ASes
- Keeps local traffic local



http://drpeering.net/FAQ/What-is-an-Internet-Exchange-Point.php

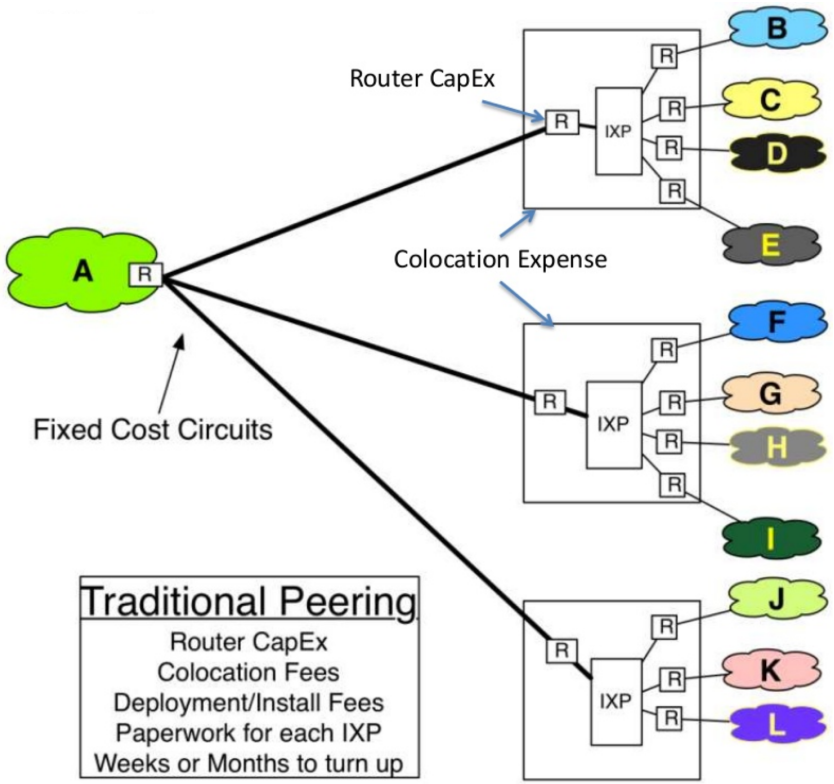
Benefits of Internet eXchange Points*

- **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

Internet Society

*Jane Coffin and Christian O'Flaherty. Internet Exchange Point (IXP) – Global Development Work. ISOC. IETF 90. July 2014

Pressure for Diverse Peering

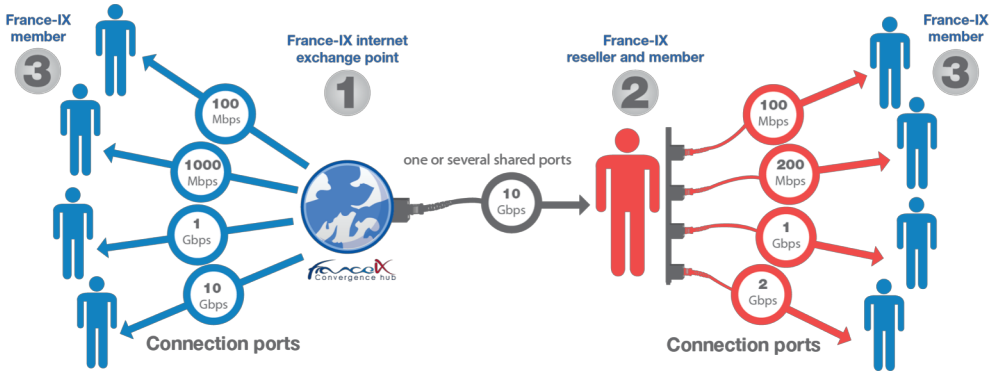


- Volume of traffic is constantly increasing
  - CDNs, Cloud, IOT
- Pressure on ASes for denser and more diverse peering connectivity
- A fundamental shift in peering practices is required

Remote Peering over IXPs

- ***Remote Peering*** is when a network peers at an IXP:

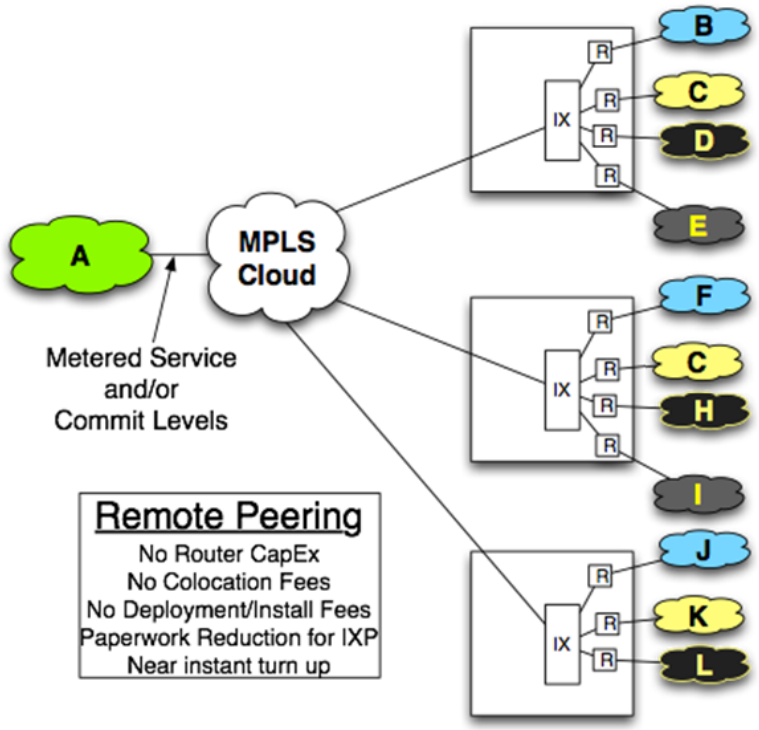
1. without having physical presence in the IXP's infrastructure
2. and/or through resellers



https://www.franceix.net/en/solutions/reseller-program

Peer Remotely?

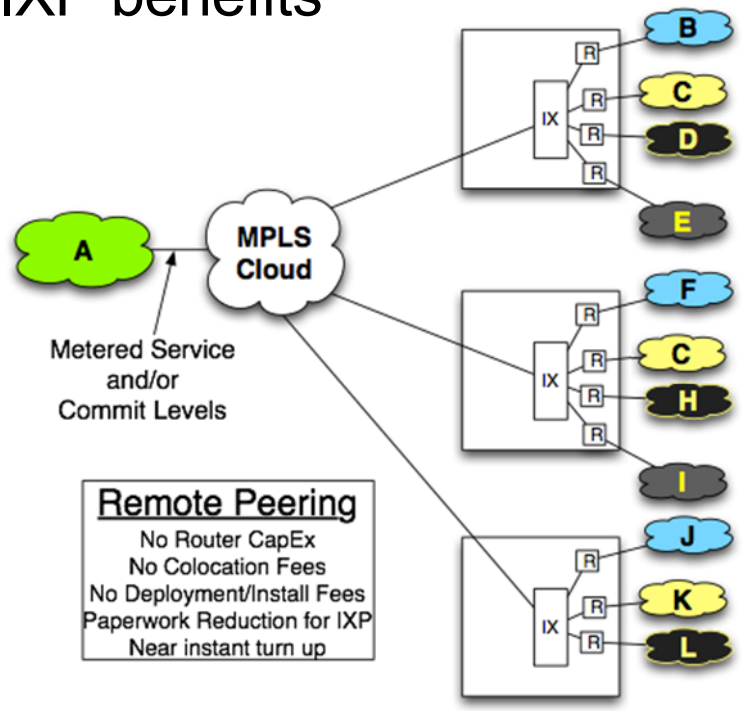
- Connect to IXP peering fabric without collocating a router at an IXP facility
  - Cut equipment, deployment, operational costs
  - Connect to multiple IXPs through a single router



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



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*

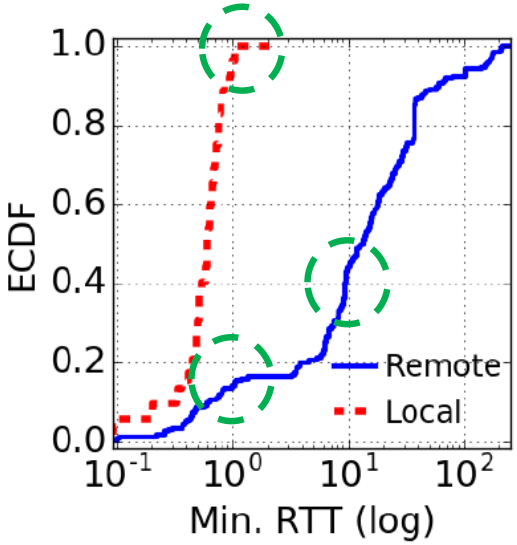
RTT-based Remote Peering Inference

- 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

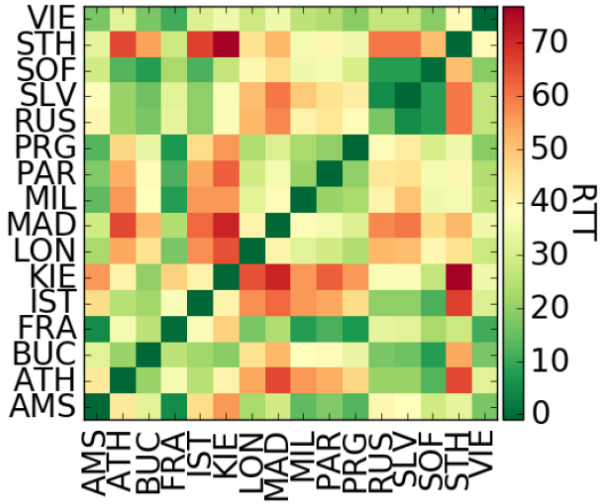
Castro, Ignacio, et al. "Remote peering: More peering without internet flattening." ACM CoNEXT 2014.

What Validation Dataset 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

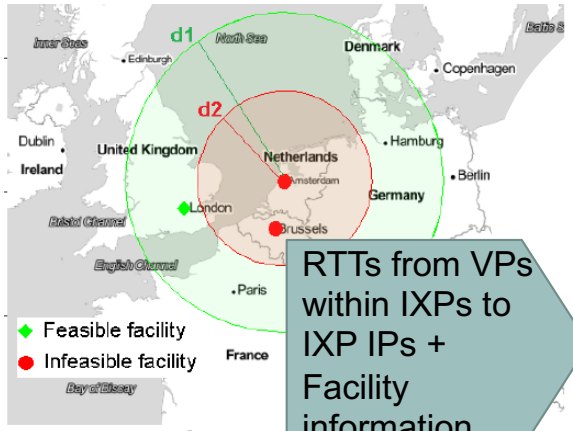


Our Methodology - How it works

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

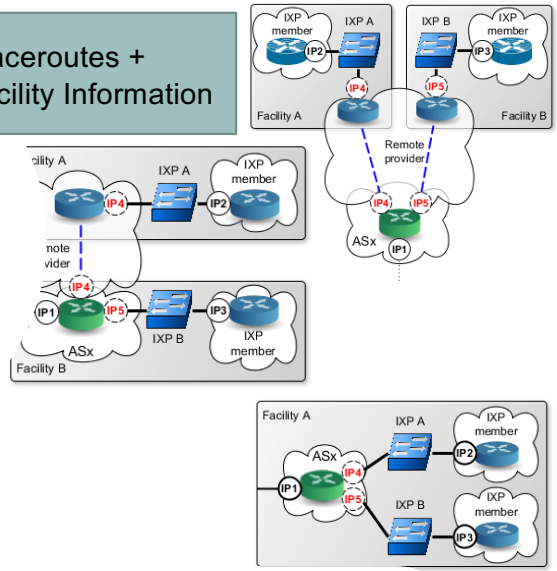
- Design aspects:
  1. Port Capacity
     - Low port capacities indicate that networks peer remotely at an IXP
  2. Ping RTT Measurements
     - RTT values provide evidence for how far (from the IXP) a peer is located
  3. Colocation Facilities
     - An AS can be a local peer of an IXP if they are colocated 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



RTTs from VPs within IXPs to IXP IPs + Facility information

Traceroutes + Facility Information



Does it work?

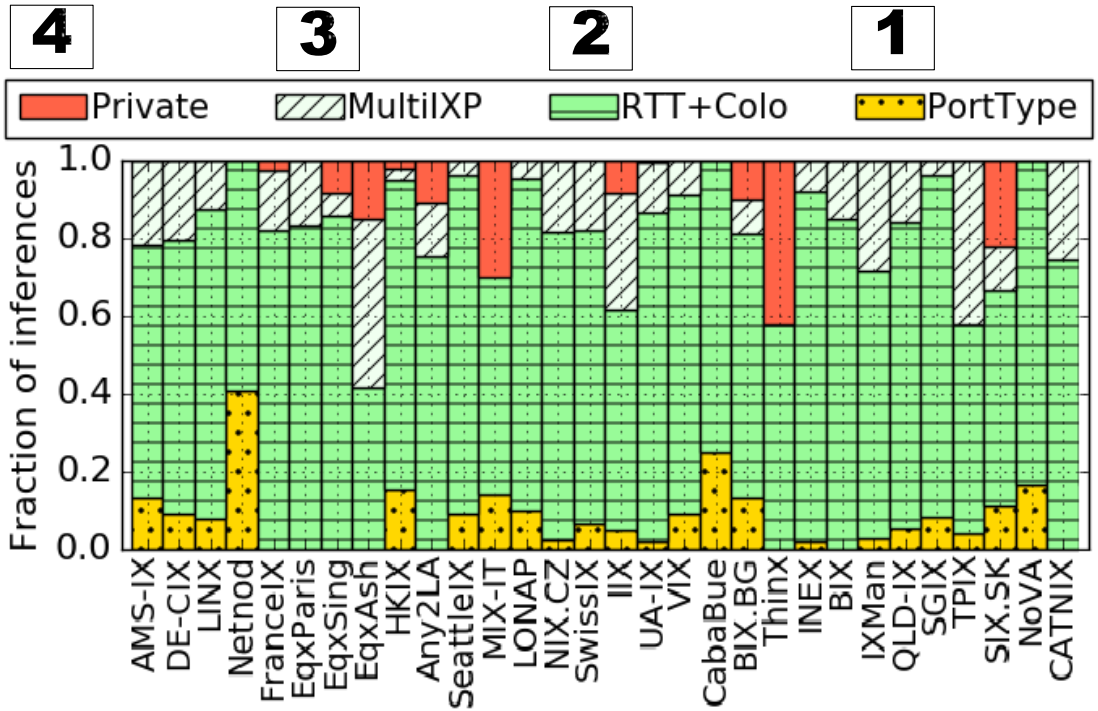
Inference Module	Coverage	Precision	Accuracy
1) Port Capacity	11%	96%	
2) RTT (*min*) + Colocation Info	76%	99.6%	94%
3) Multi-IXP	53%	97.5%	93%
4) Private Links	49%	95%	85%
Combined	93%	95%	94.5%

Remote Peering in the Wild

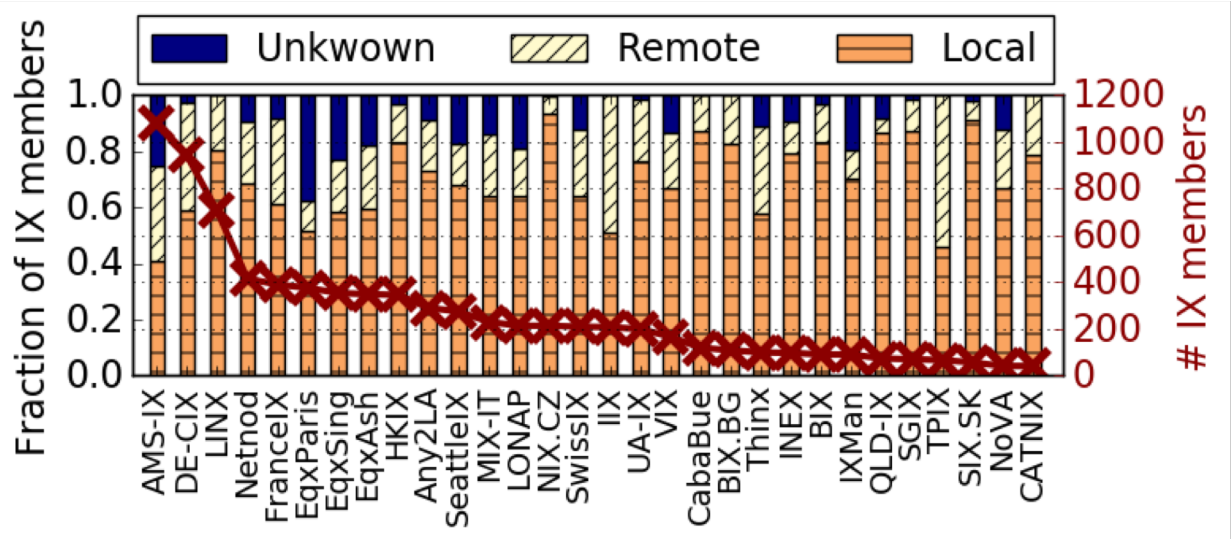
Contribution per Inference Module

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



Inference Results



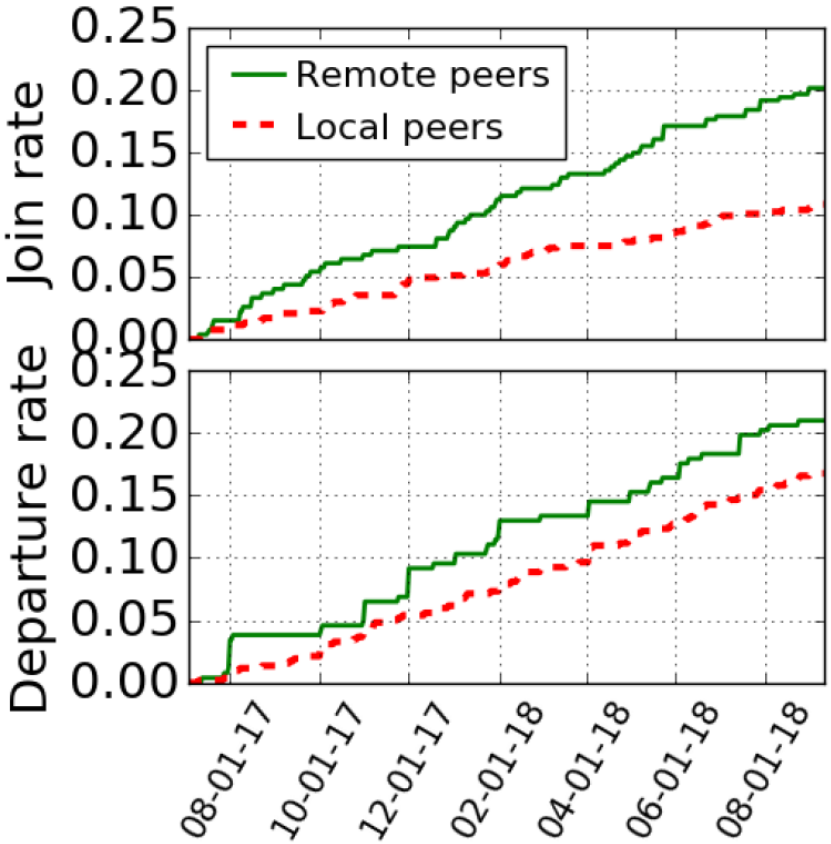
We also found:

- ✓ **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

Growth Rate

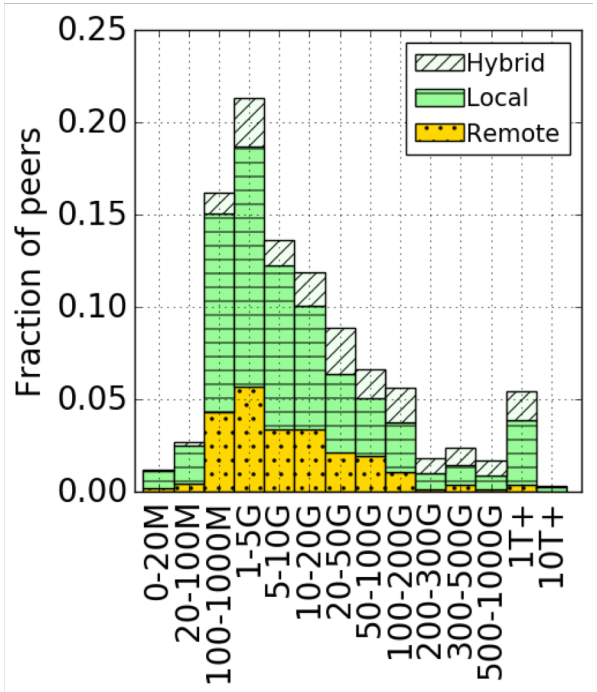
1. **5** IXPs between **2017/07 – 2018/10**
   - LINX, LONAP, HKIX, THINX, UAIX
2. Also confirmed from annual reports of AMS-IX, DE-CIX, France-IX

- Remote peers grow ***twice*** as much compared with local peers
- Remote peers exhibit higher join (x2) and departure (x1.25) rates
- 18 remote peers switched to local

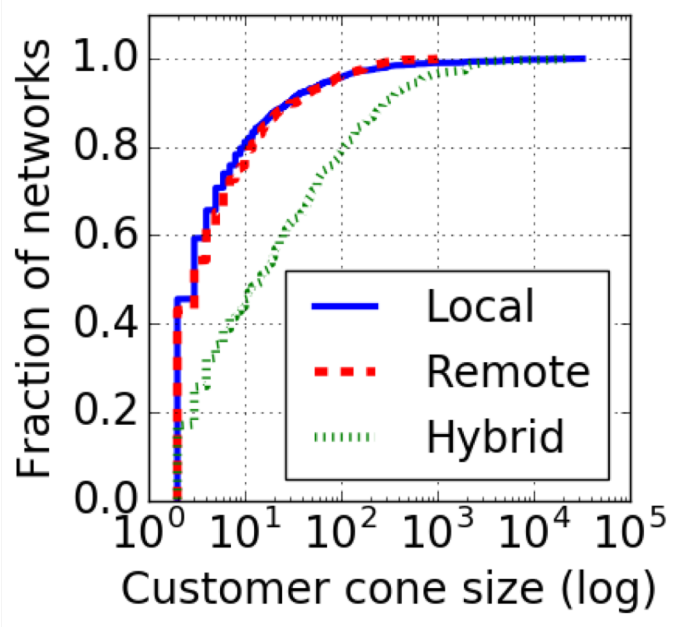


Other Features of IXP Members

- Aggregate traffic levels



- Customer cone size

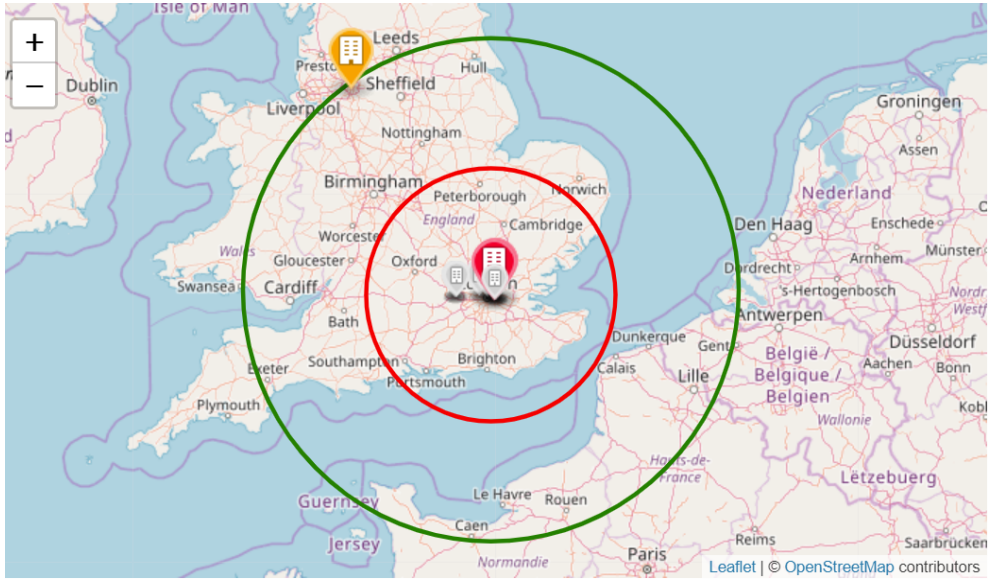


RP Routing Implications

- 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

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

IXP's Facilities



IXP members

IXP Facilities

Telehouse - London (Docklands North) **Outside range**

Telehouse - London (Docklands East) **Not present**

Digital Realty London (Sovereign House) **Not present**

Digital Realty London

AS47622 is remote. Minimum RTT: 4 ms. Possible remote PoPs: Equinix Manchester Williams/Kilburn (MA1) - GB

AS15169 is local. Minimum RTT: 1 ms

Portal

- Remote/Local peering visualization
- Filtering remote/local peers in the IXP and Facility level
- REST API
- Publicly available soon

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

Thank You

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Future Work:

- An extensive analysis including more IXPs back in time
- Interpretation of traffic levels of remote and local IXP peering interconnections