FORTH
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Uncovering Remote Peering Interconnections at IXPs

To appear in IMC, Boston, 2018

V. Kotronis, P. Sermpezis, P. Gigis, L. Manassakis, C. Dietzel, S. Konstantaras,
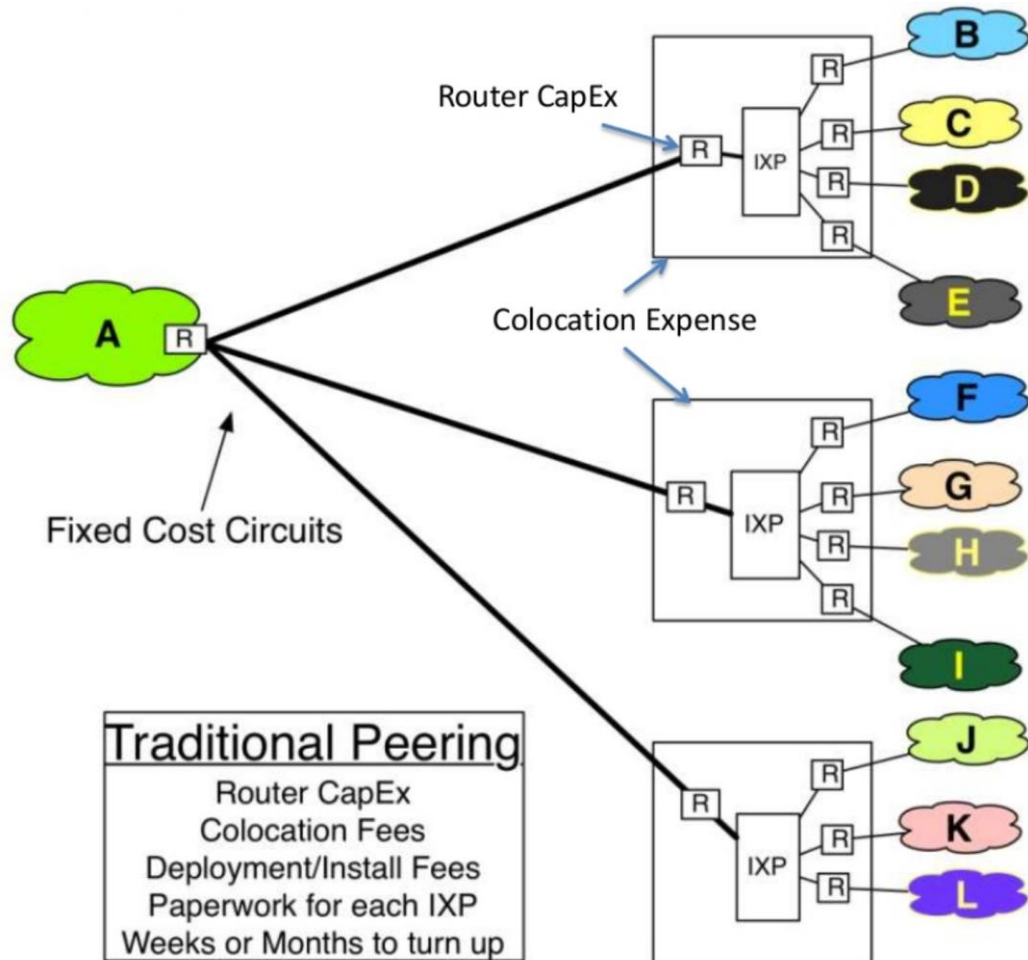
X. Dimitropoulos, V. Giotsas

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™

Pressure for Diverse Peering

Router CapEx

Colocation Expense

Fixed Cost Circuits

Traditional Peering
Router CapEx
Colocation Fees
Deployment/Install Fees
Paperwork for each IXP
Weeks or Months to turn up

- 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

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Peer Remotely?

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

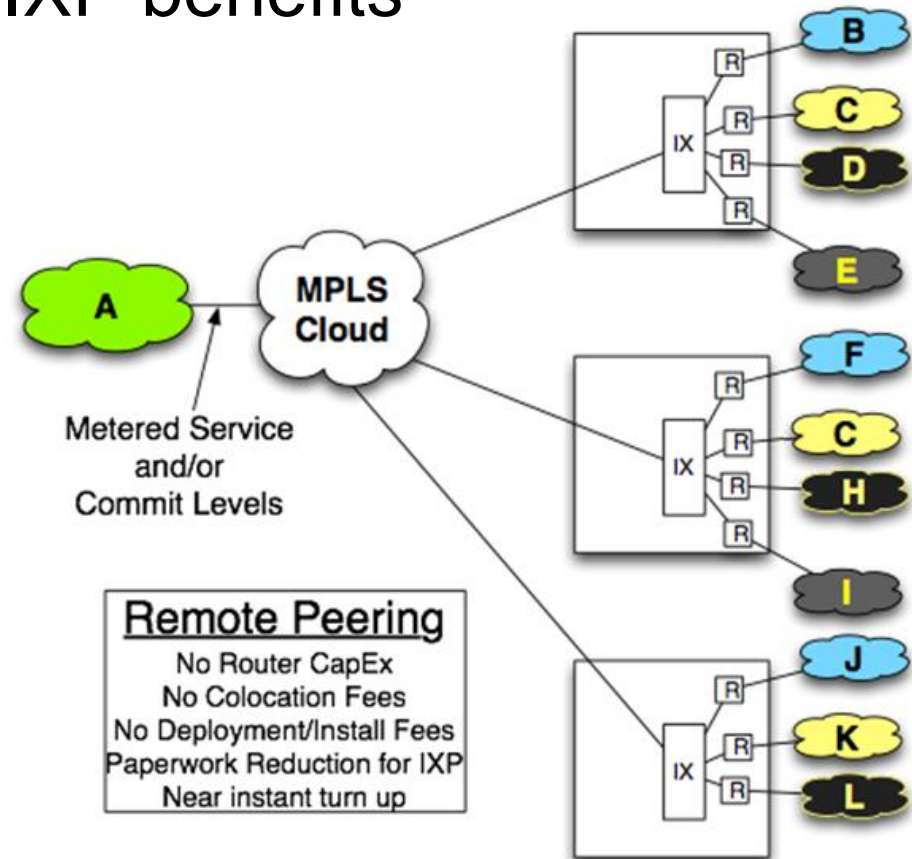 - Connect to multiple IXPs through a single router
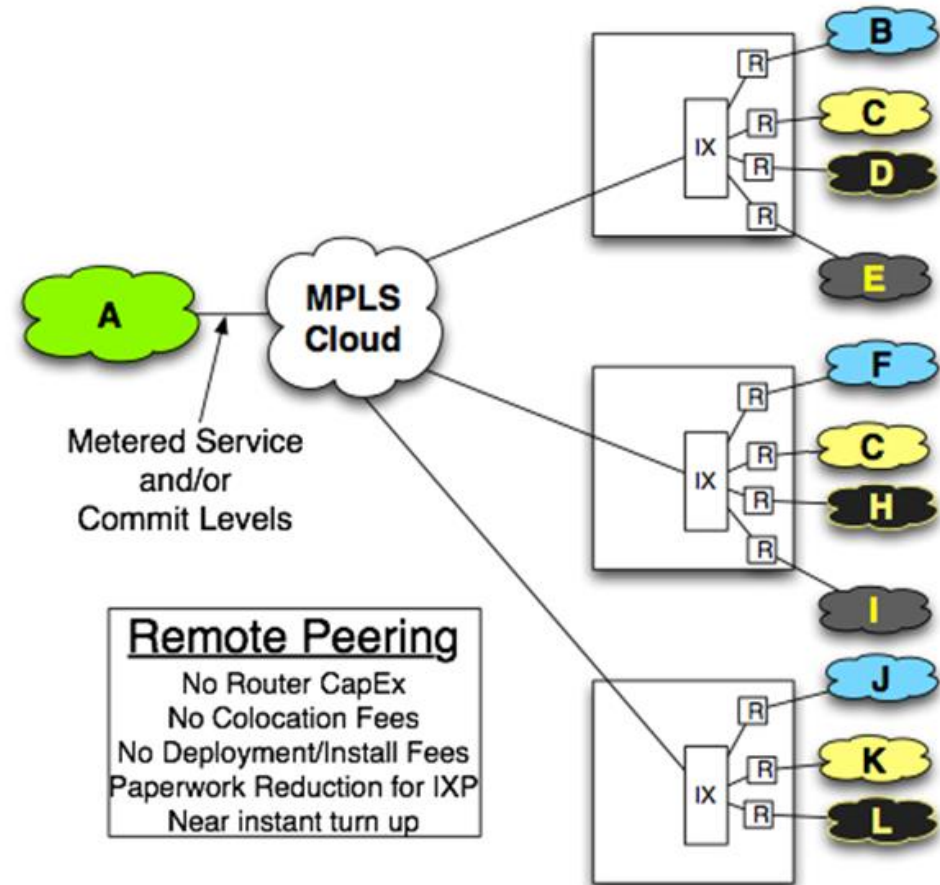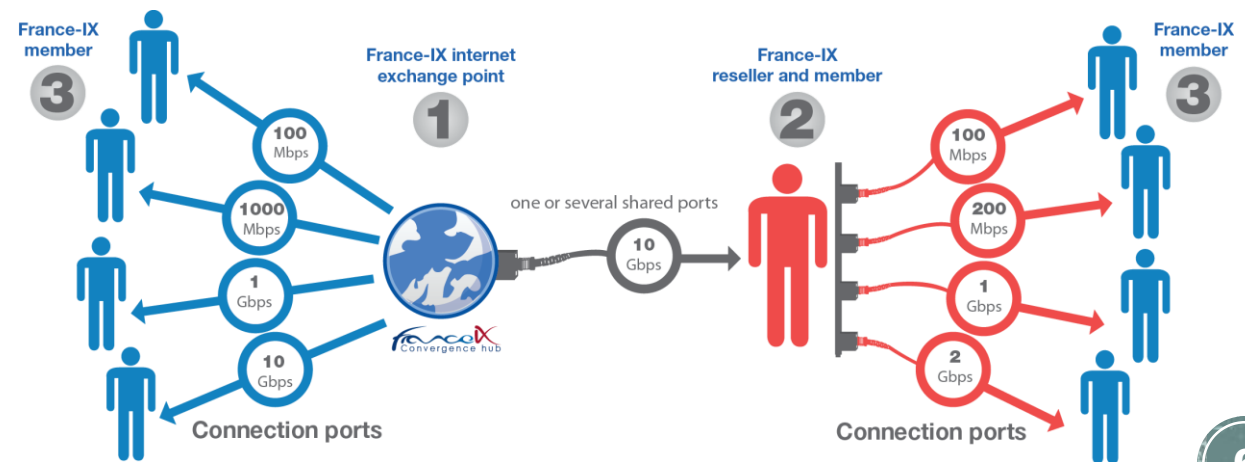
Yes, but...

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
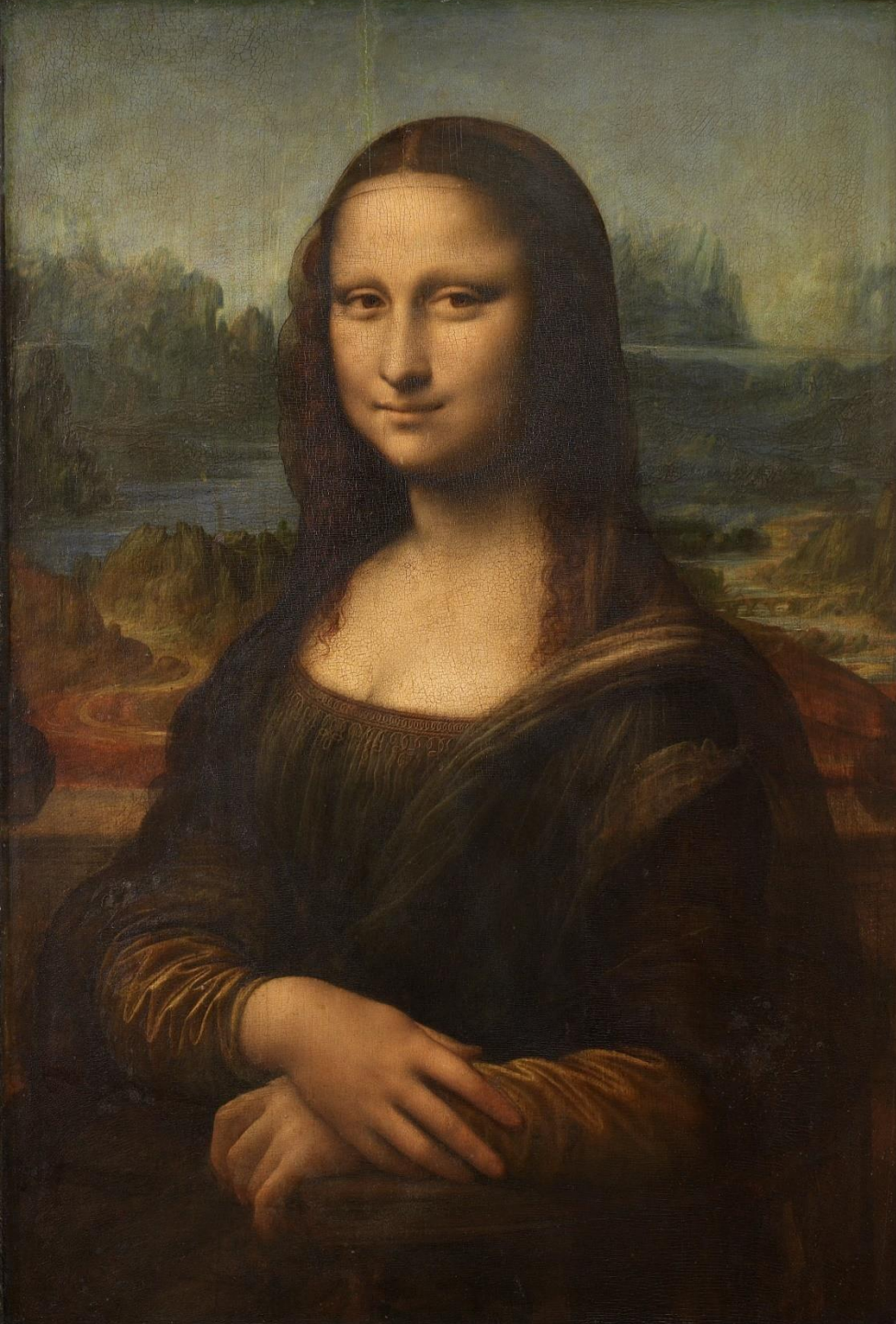
2. and/or through resellers

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

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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 Ground-Truth Says:

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

- **18%** of remote peers have < 1ms RTT
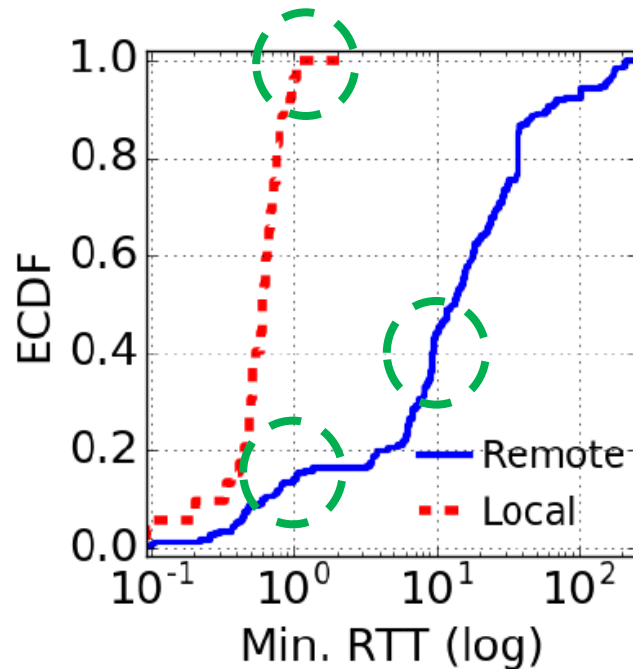
- **Wide-area IXPs: 87%** of facility pairs have **>10ms** median RTT (NET-IX)

- **~14%** of IXPs are wide-area
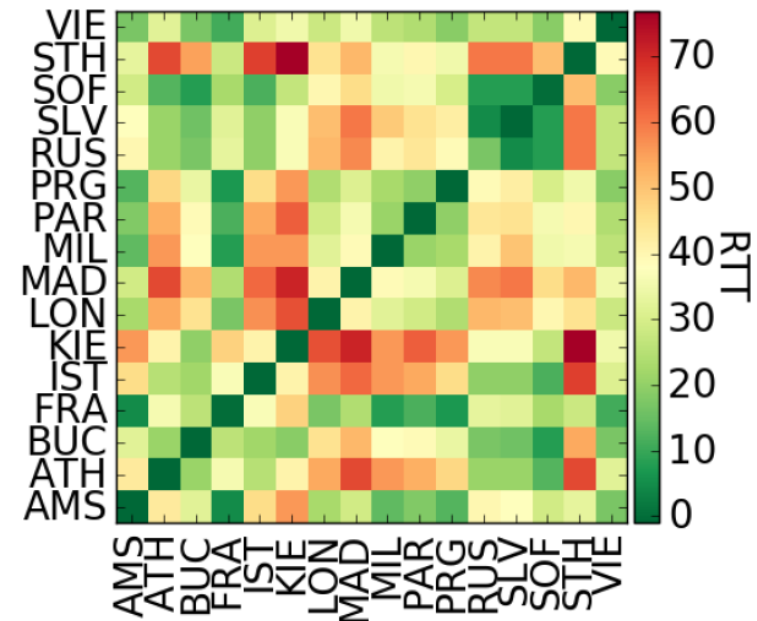
Our Methodology - How it works

- 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
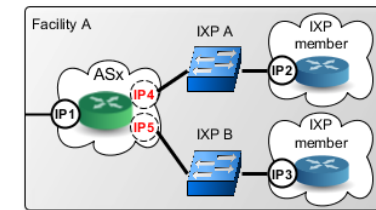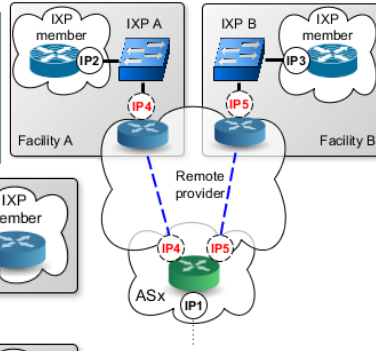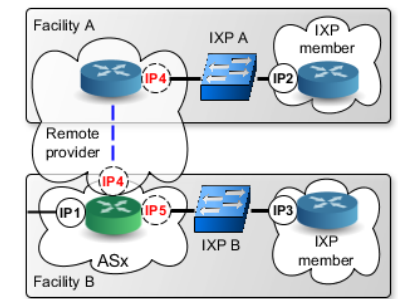
Algorithm Overview – 4 Modules

RTTs from VPs within IXPs to IXP IPs + Facility information
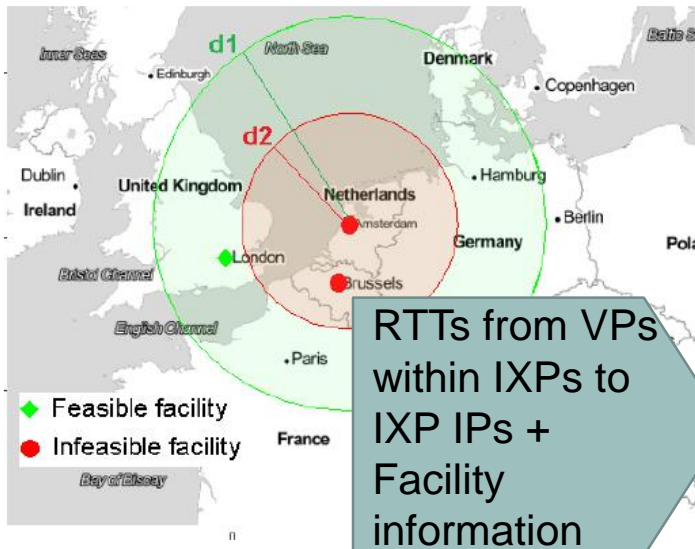
Infer the distance between IXP member and Facility

2

Identify multi-IXP routers

3

Traceroutes + Facility Information

Port capacities from IXP websites and PeeringDB

Find reseller customers

1

Remote
or
Local
or
Unknown

Localize at the Facility level the private connectivity

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Traceroutes + AS-to-Facility mappings

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%

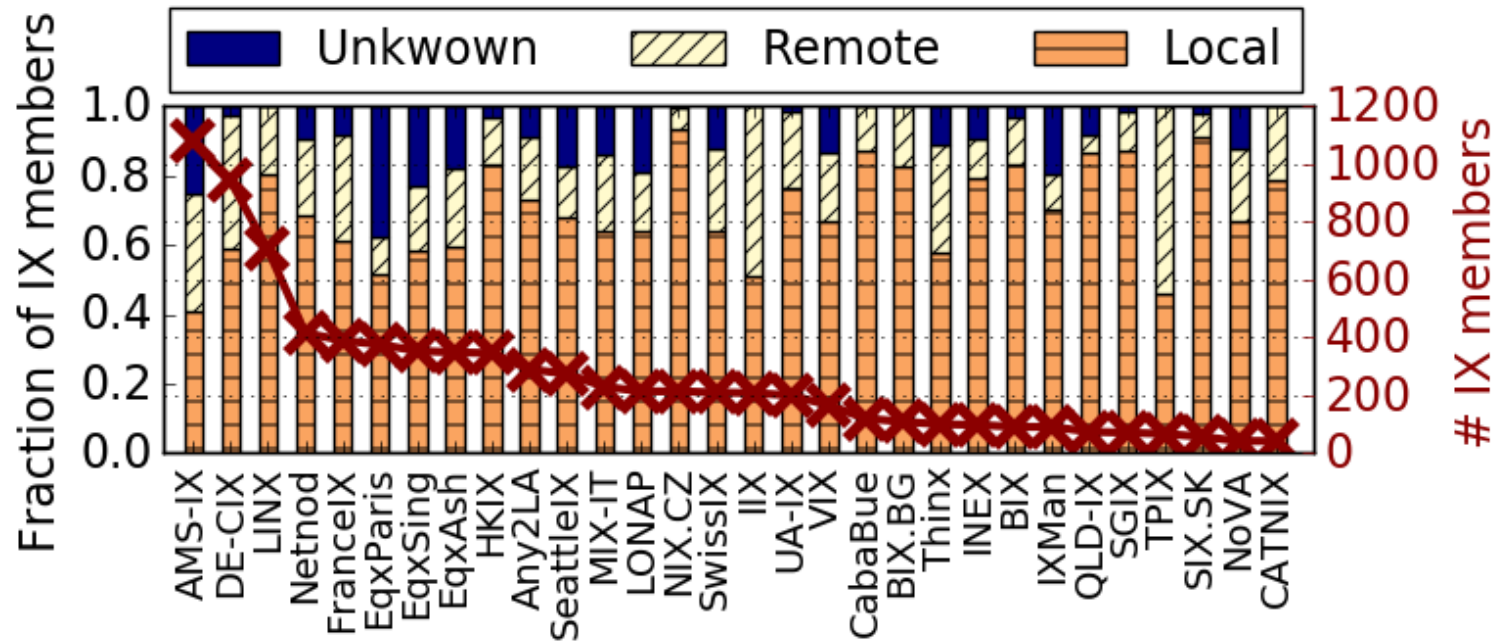# Remote Peering in the Wild

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
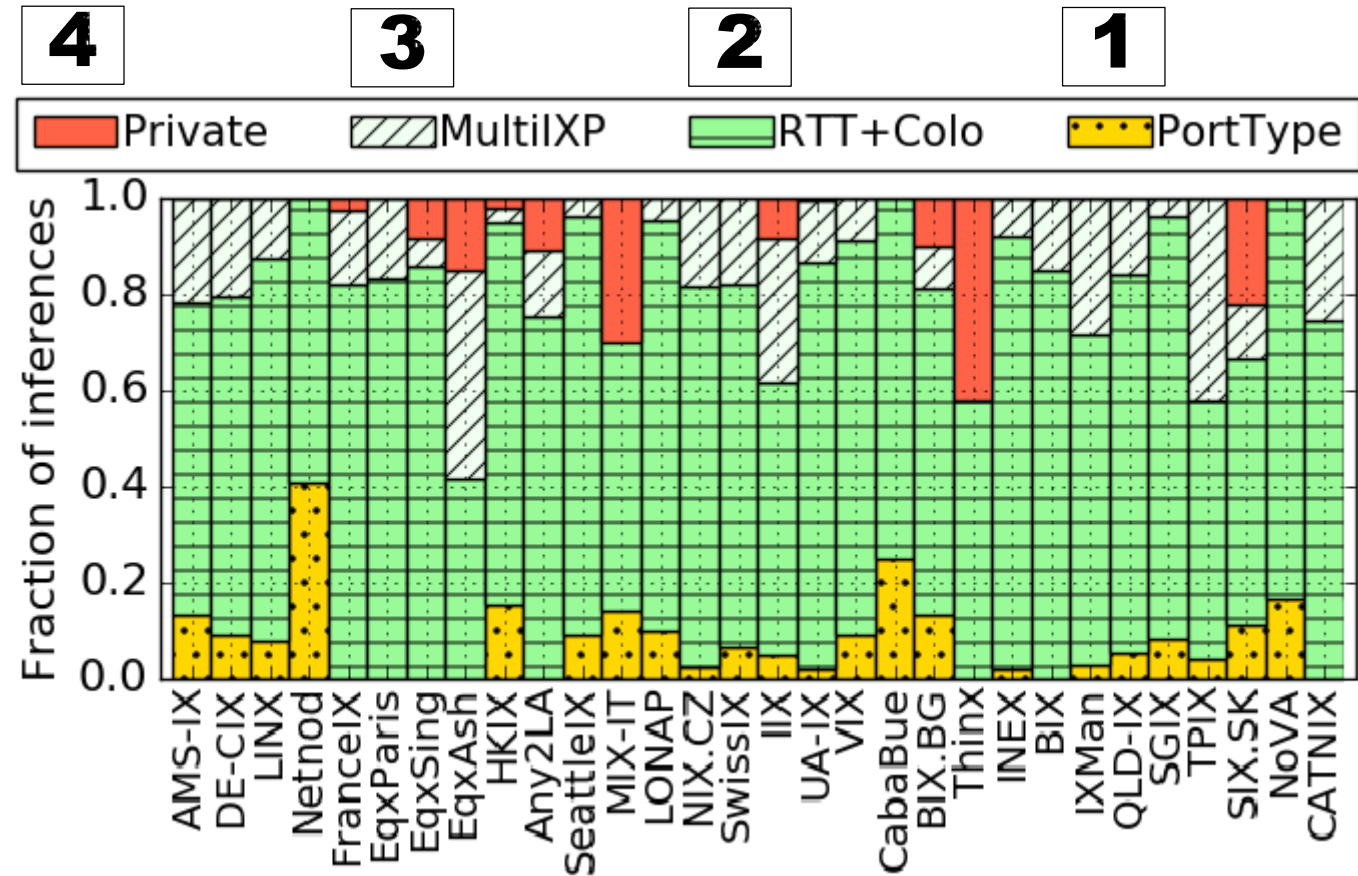
Inference Results

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. 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 *twice* as much compared with local peers

- Remote peers exhibit higher join (x2) and departure (x1.25) rates
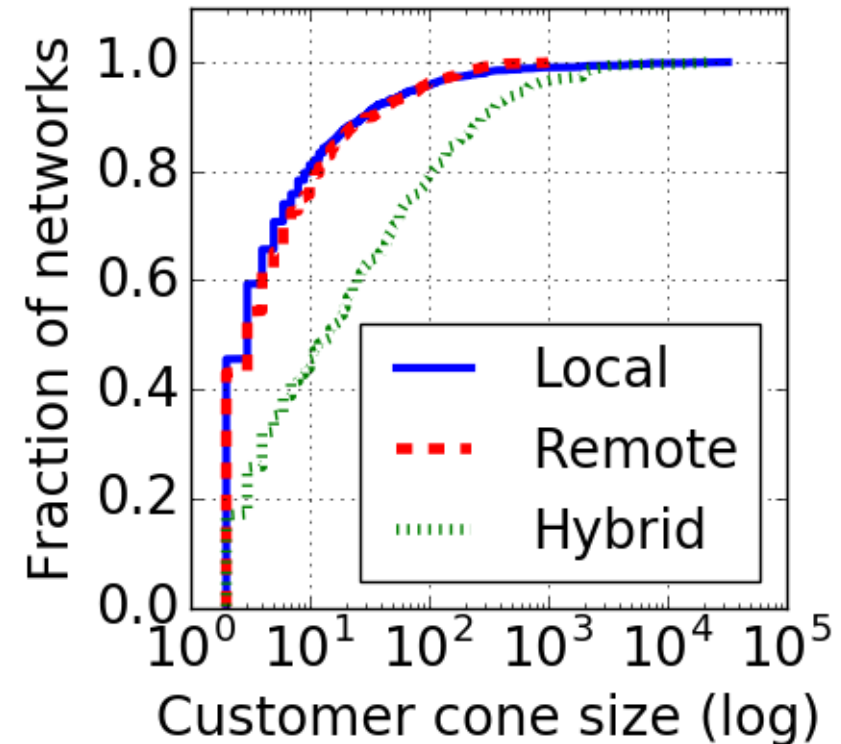
- 18 remote peers switched to local
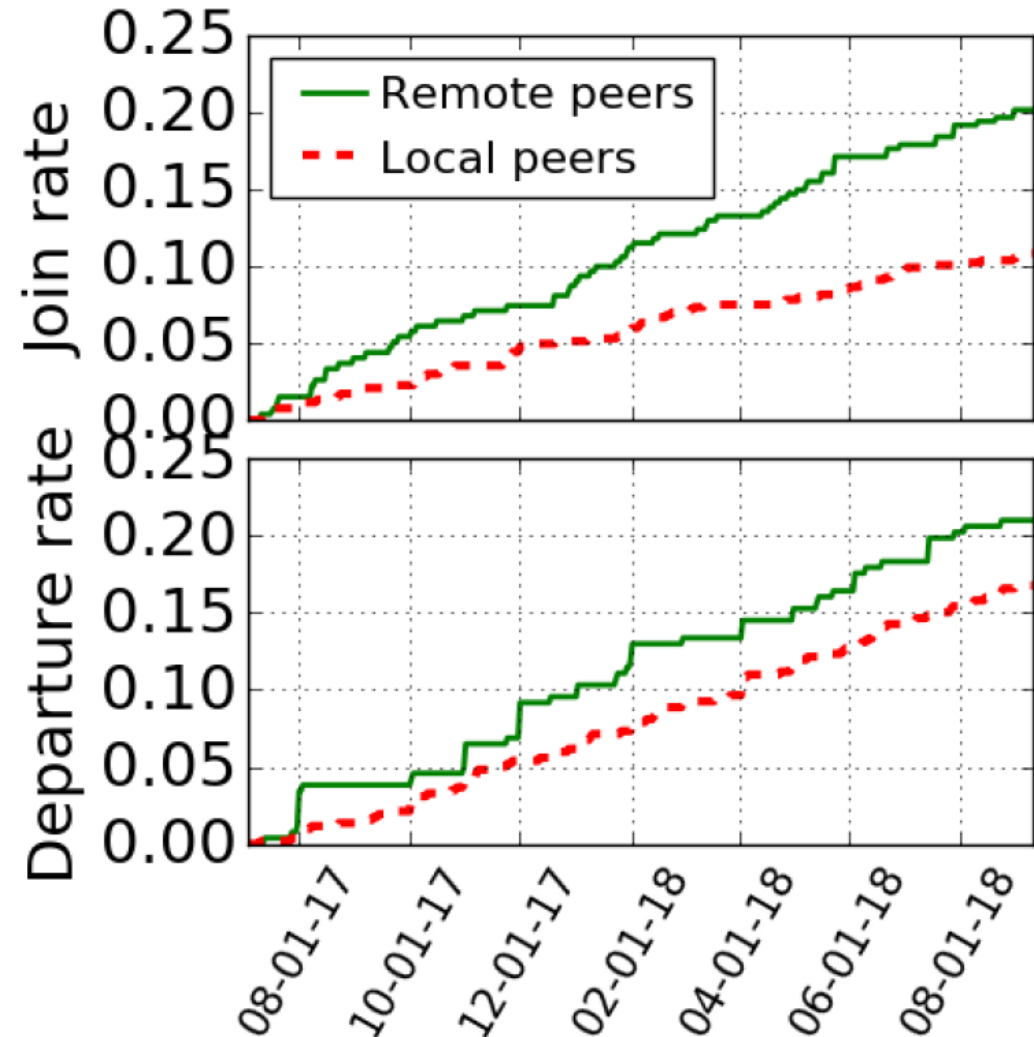
Other Features of IXP members

- Aggregate traffic levels
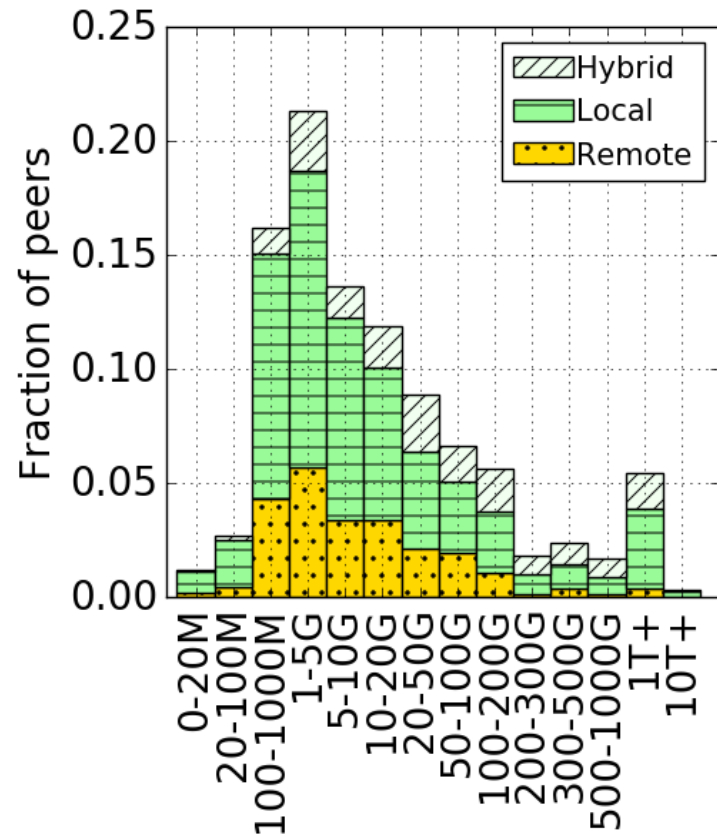
- Customer cone size

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

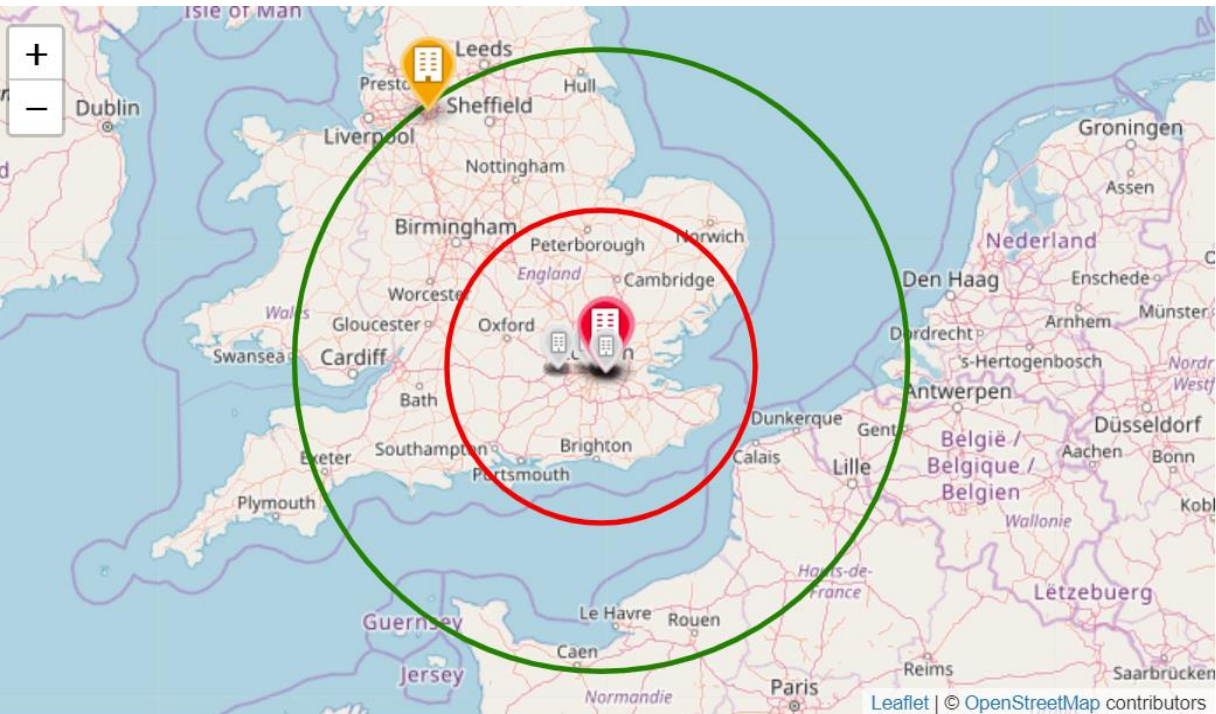**Facilities of AS**

IXP's Facilities

Queried AS

IXP members ▾

IXP Facilities

Telehouse - London (Docklands North) **Present**

Telehouse - London (Docklands East) **Present**

Digital Realty London (Sovereign House) **Present**

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

Equinix London Docklands (LD8) **Present**

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

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

Conclusions

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

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

o 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
http://www.inspire.edu.gr/wp-content/pdfs/uncovering_remote_peering_interconnections_v1.pdf

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Future Work

o 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

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

Thank You

I ♥ AMSTERDAM

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