

Following the Data Trail: An Analysis of IXP Dependencies

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S O K E N D A I



I I J Internet Initiative Japan

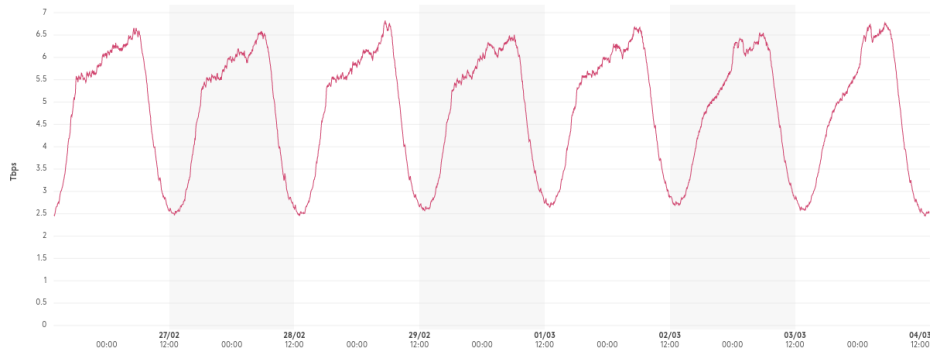


N I I 大学共同利用機関法人 情報・システム研究機構
国立情報学研究所
National Institute of Informatics

Motivation

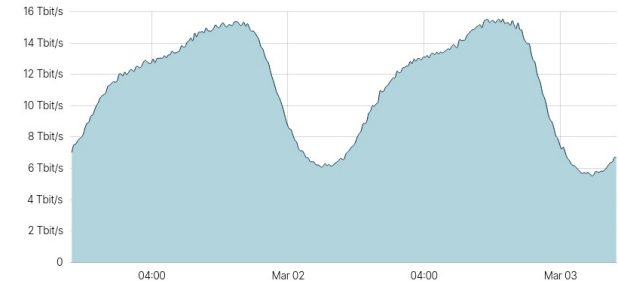
- Internet eXchange Points (IXPs) are important for the internet topology
- Connect many networks
- Increasing size and usage

LINX LON1: 6.83 Tbps



<https://portal.linx.net/services/lans-snmp>

DE-CIX Frankfurt: 15.56 Tbps



<https://www.de-cix.net/en/locations/frankfurt/statistics>

TOTAL DAILY

AMS-IX: 11.64 Tbps



<https://www.ams-ix.net/ams/documentation/total-stats>

Motivation

- IXPs are not perfect
- Understand inter-dependencies of IXPs and networks
- New input for risk assessment of operators

OUTAGE ANALYSES

Understanding Internet Exchanges via the DE-CIX Outage

By Alex Henthorn-Iwane | April 13, 2018 | 6 min read

<https://www.thousandeyes.com/blog/network-monitoring-de-cix-outage>

LINX LON1 Outage – March 2021

23rd March 2021

Between 11:15-11:28 and again between 11:41-11:57 there was a degradation of service on our LON1 exchange affecting a small number of members.

<https://www.linx.net/incidents-log/>

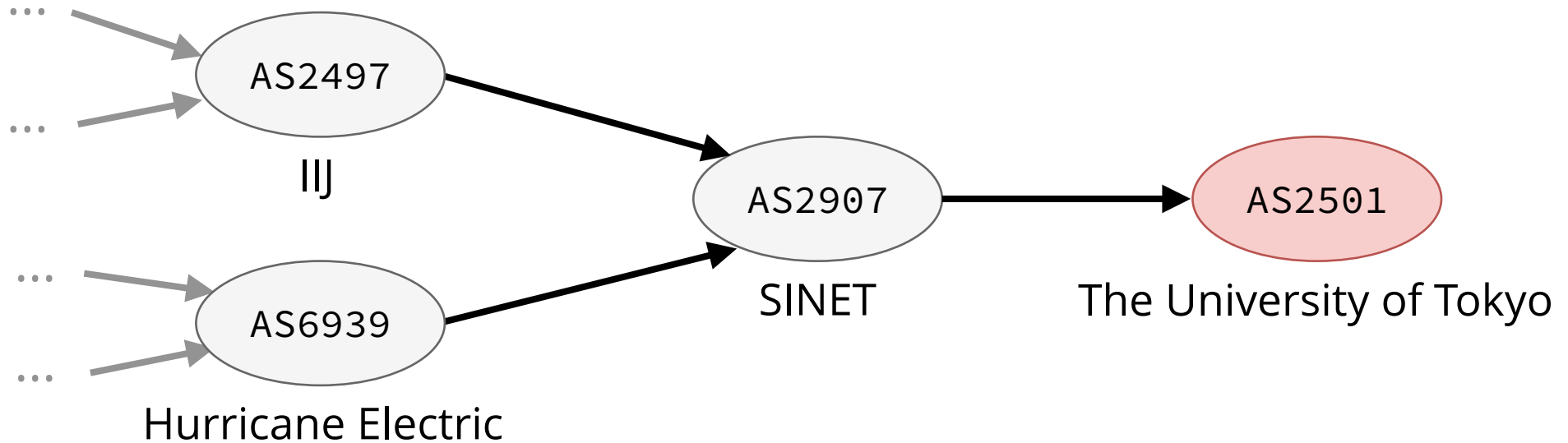
Platform Incident

Between 19:08 CET and 23:04 CET on November 22, 2023, and from 09:38 CET to 10:25 CET on November 23, 2023, customers connected to the Amsterdam infrastructure experienced active flapping of LACP and BGP sessions. At the peak, the total traffic passing through the AMS-IX platform dropped to 2.1 Tb/s. BGP sessions were reduced from 885 to 550 (IPv4) and 800 to 450 (IPv6).

<https://www.ams-ix.net/ams/outage-on-amsterdam-peering-platform>

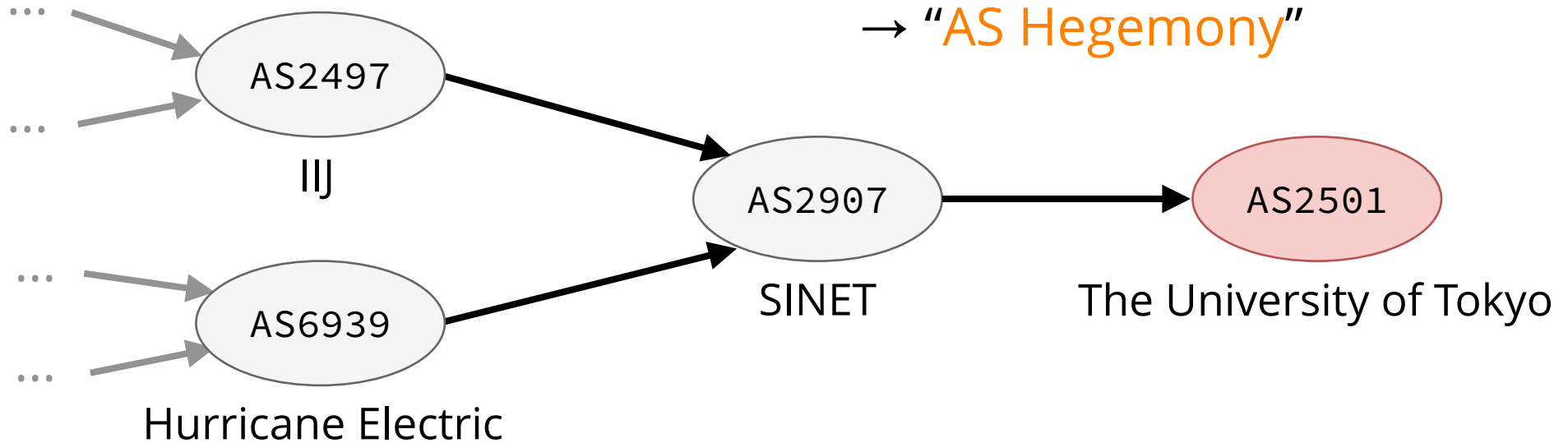
How to infer AS dependencies?

Previous work built topology from BGP to infer AS dependencies



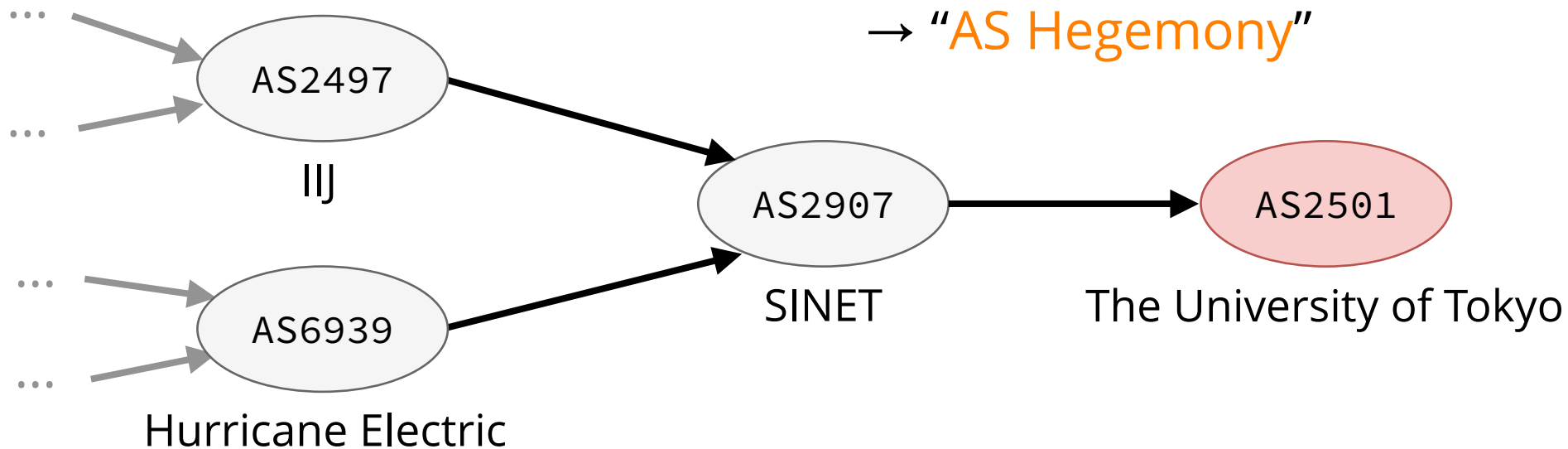
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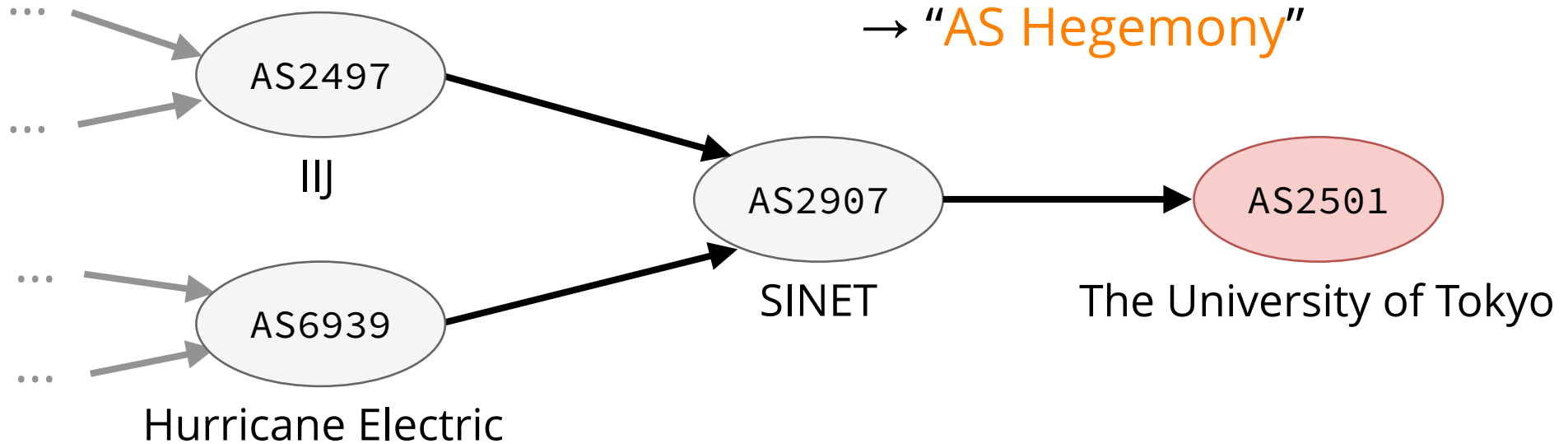
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Problem: IXPs are (generally) not visible in BGP

How to infer AS dependencies?

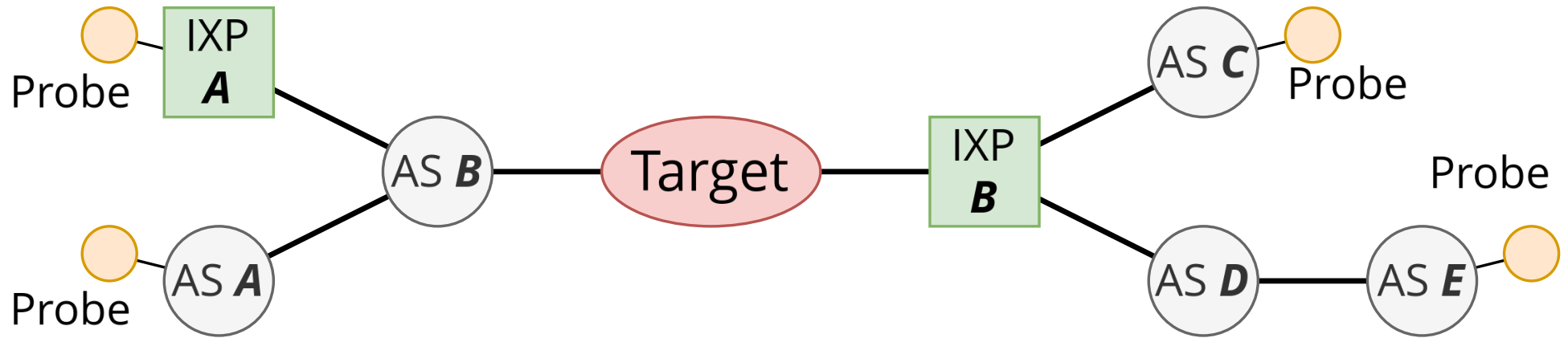
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Problem: IXPs are (generally) not visible in BGP

Solution: Built topology from traceroutes → IXP peering LAN visible

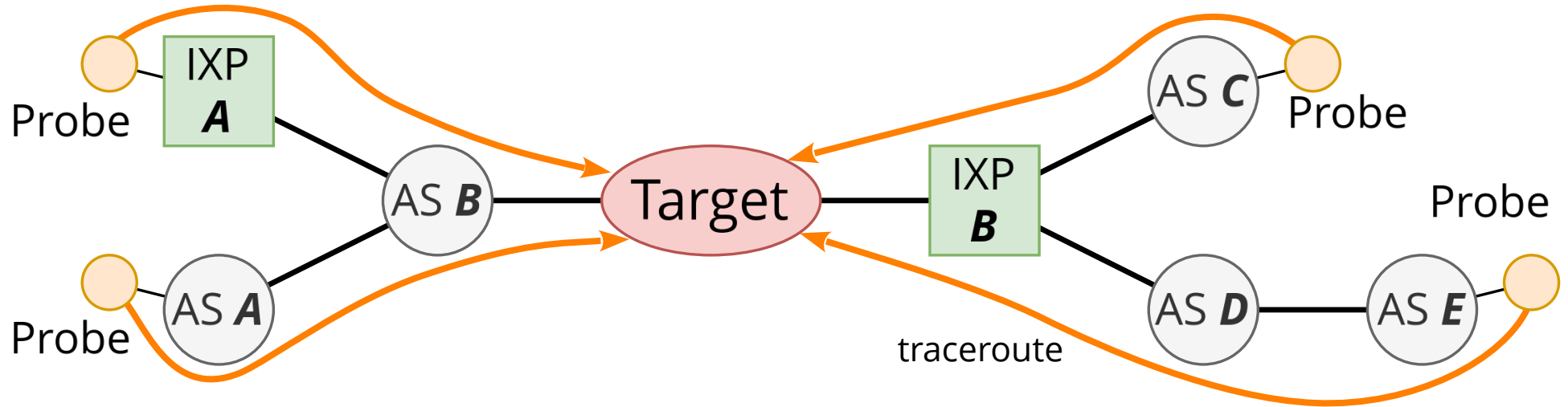
How to infer IXP dependencies?



(Simplified)

1. Run traceroutes from probes to the target AS
2. Map the hops to an ASN and/or IXP
3. Build a topology and calculate AS Hegemony

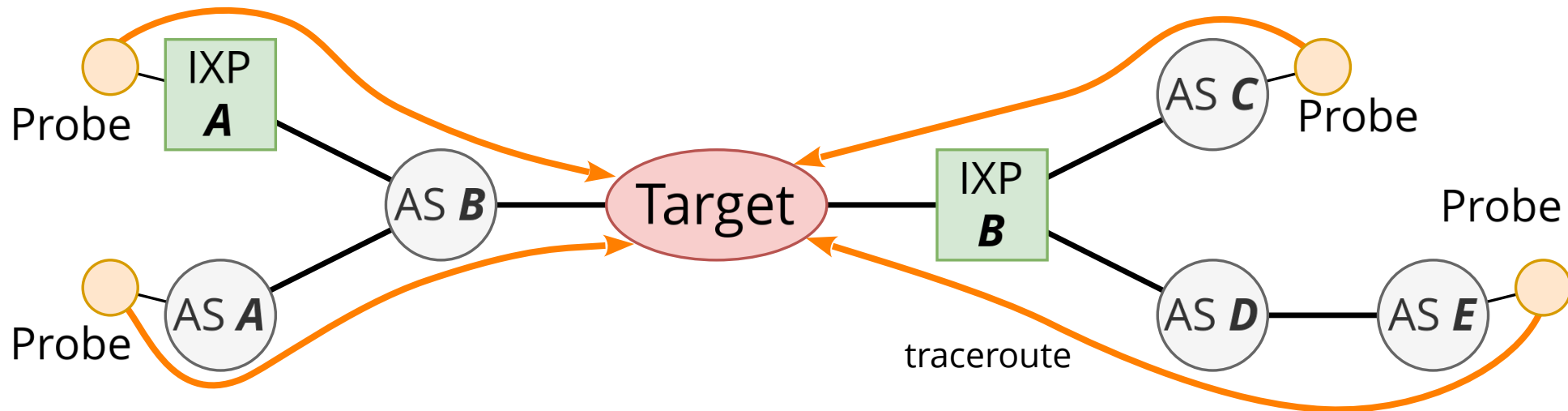
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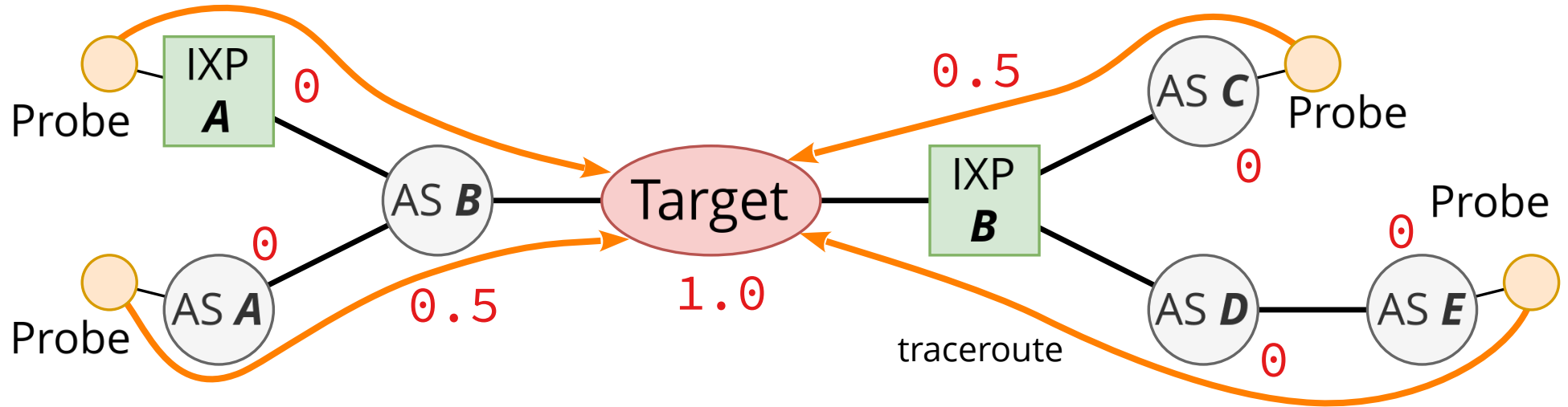
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AS Hegemony score is based on the share of paths going through each AS/IXP.

(plus some mechanisms to account for sampling bias)

How to infer IXP dependencies?



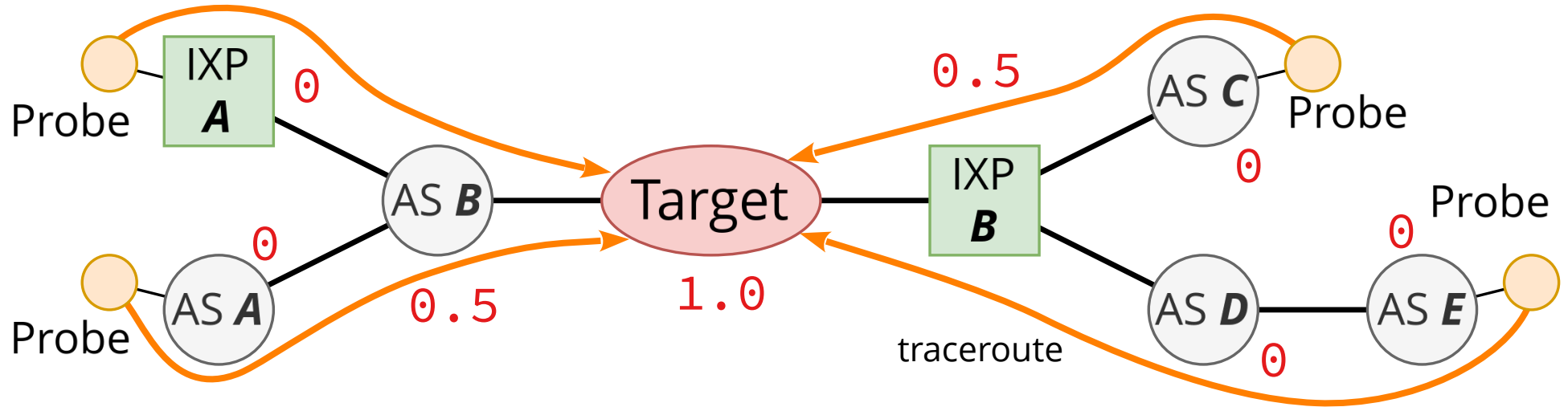
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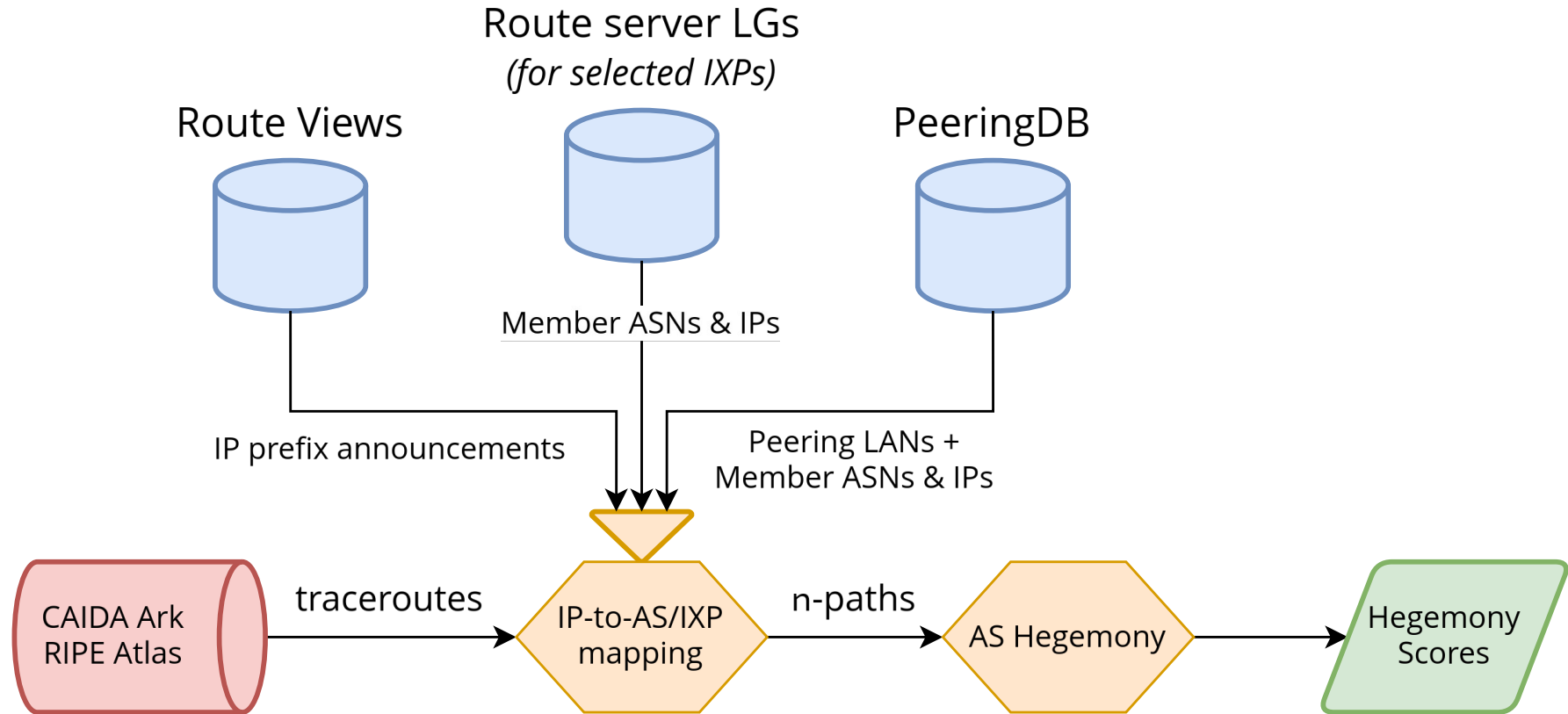
1. Run traceroutes from probes to the target AS
2. Make a dependency graph
3. Build a topology and calculate AS Hegemony

Dependency: AS or IXP with a Hegemony score of ≥ 0.1

AS Hegemony score is based on the share of paths going through each AS/IXP.

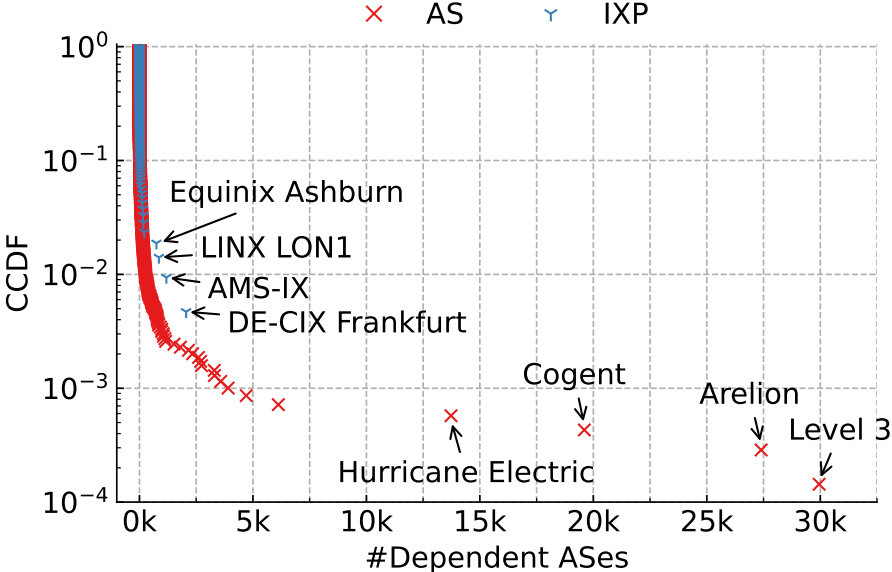
(plus some mechanisms to account for sampling bias)

Data sources / pipeline



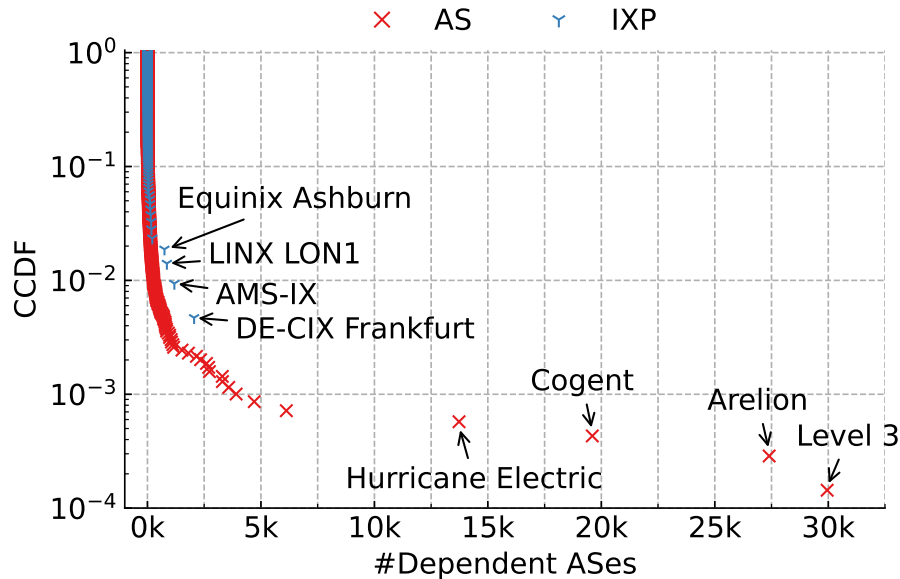
Results — Overview

Number of dependents per AS/IXP



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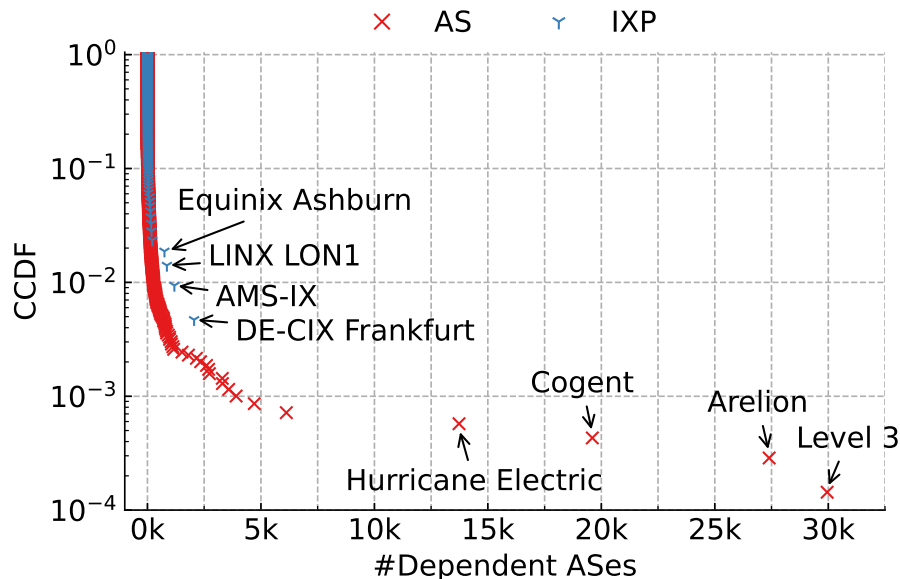
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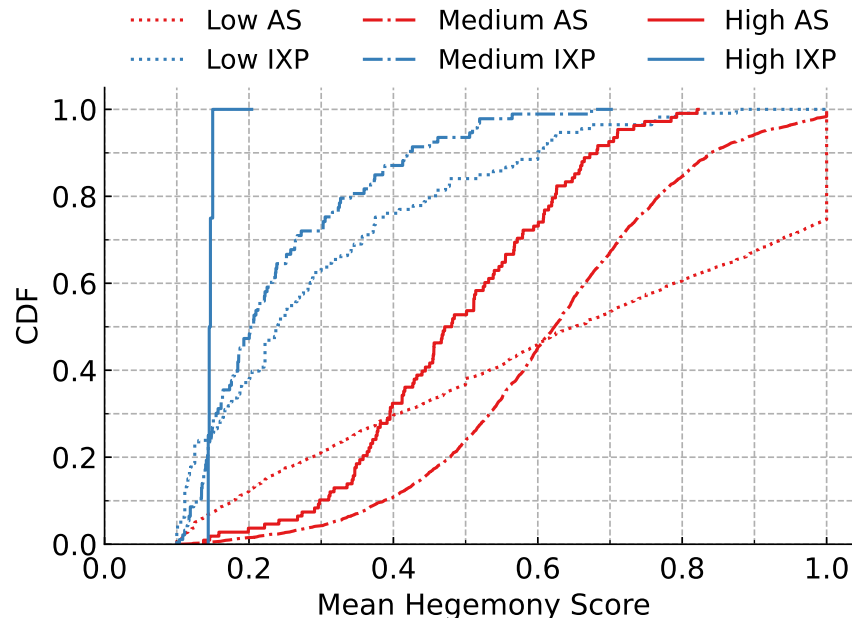
- IXPs have less dependents than ASes
- A few IXPs stand out

Results — Overview

Number of dependents per AS/IXP



Distribution of Hegemony Scores



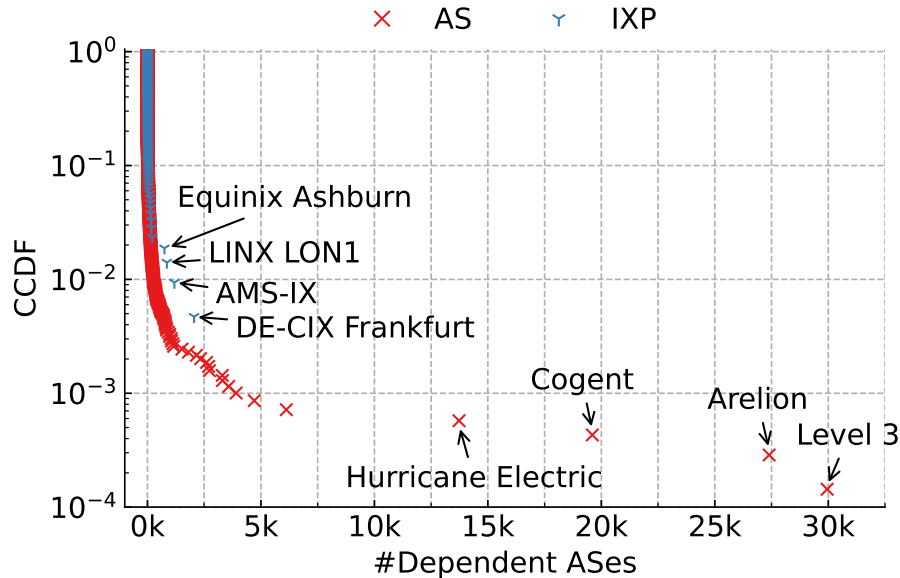
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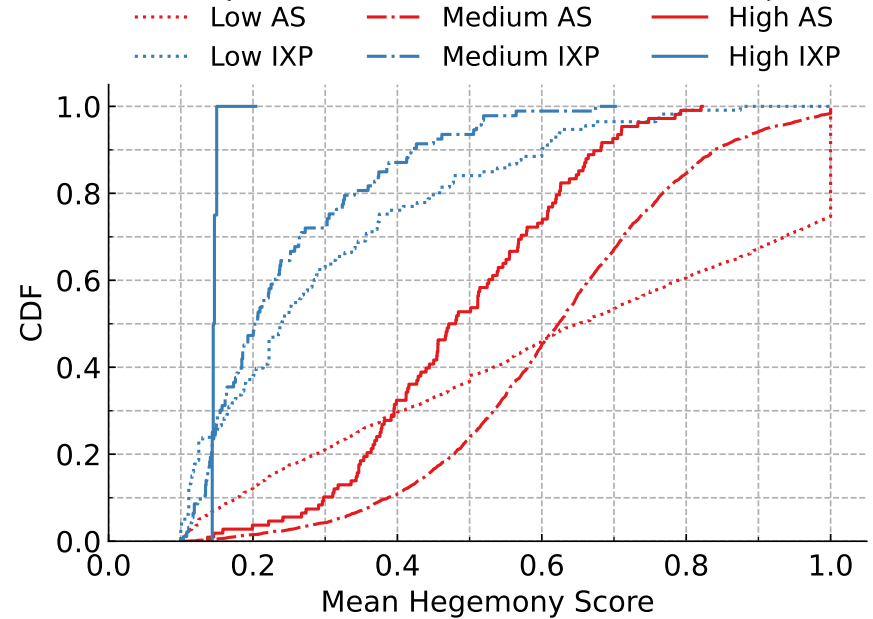
≤ 2 dependents

> 180 dependents

Number of dependents per AS/IXP



Distribution of Hegemony Scores



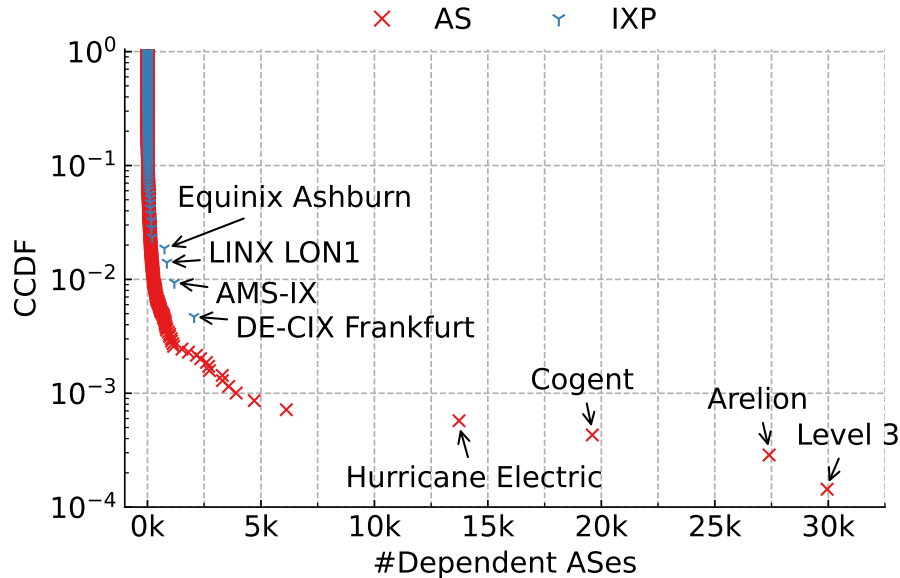
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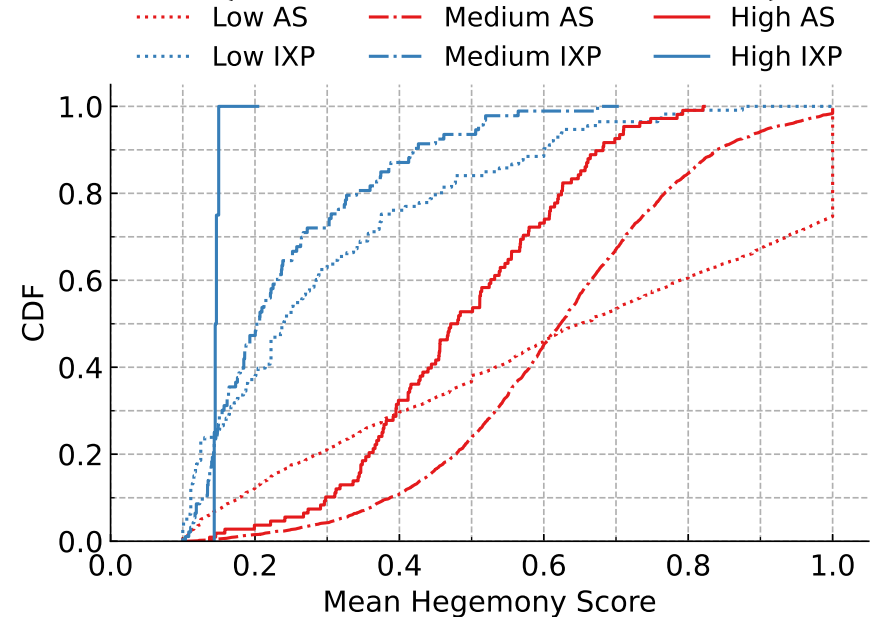
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Distribution of Hegemony Scores



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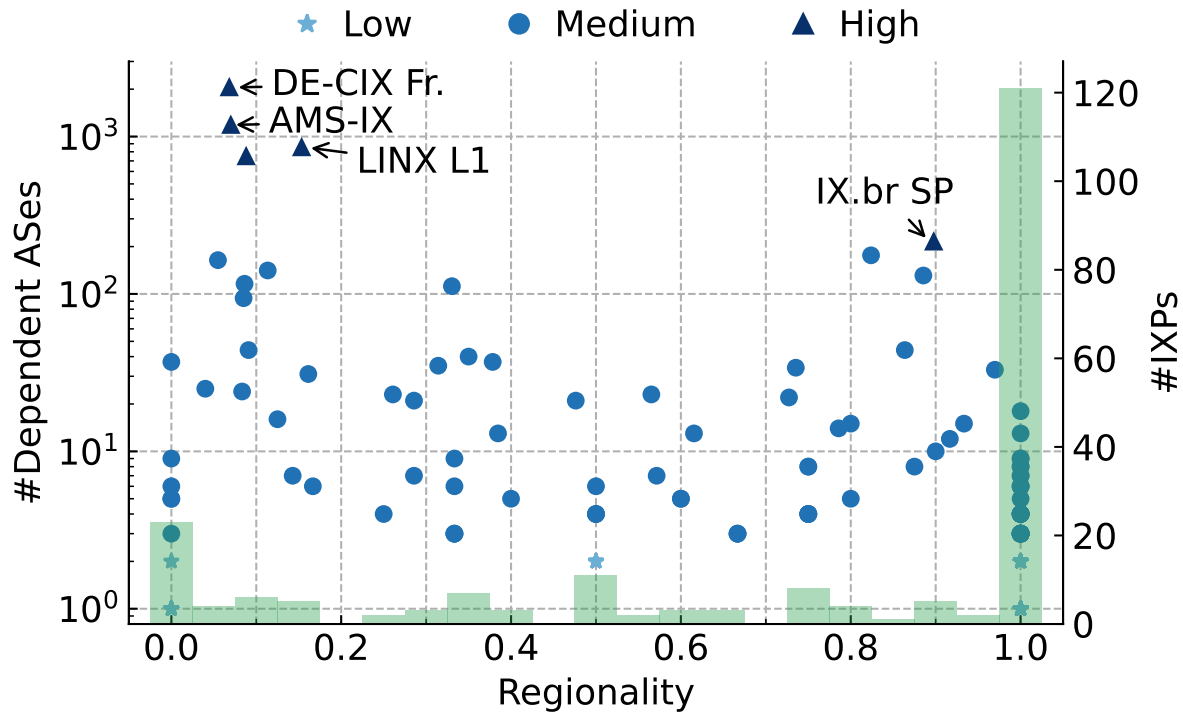
- IXPs have weaker dependencies than ASes
- IXPs/ASes with many dependents have weaker dependencies

Results — Regionality

Regionality: “The fraction of dependents that are located in the same country as the IXP.”

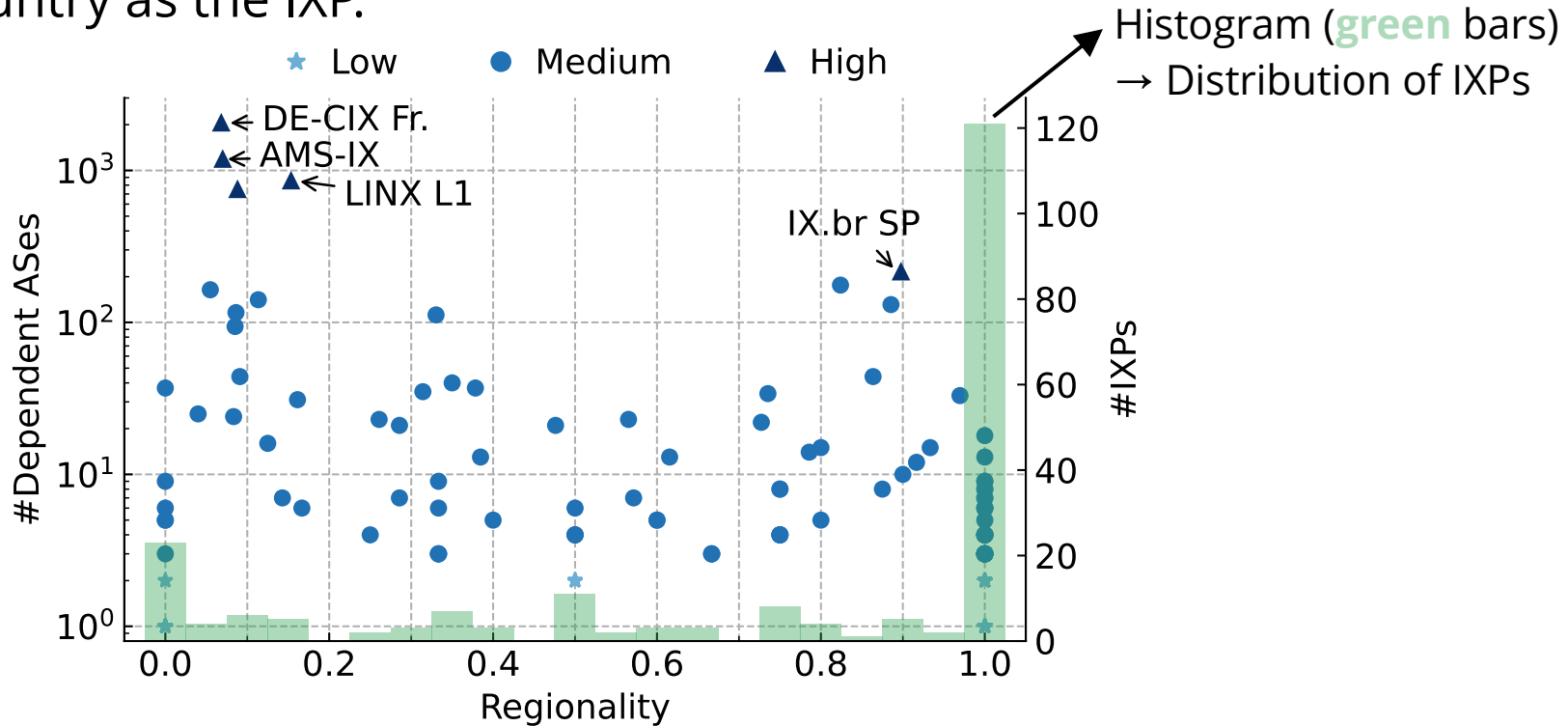
Results — Regionality

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Results — Regionality

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Results — Case Study

(Top 10) Countries with most dependents

DE-CIX Frankfurt

1050 members | 2055 dependents

IX.br São Paulo

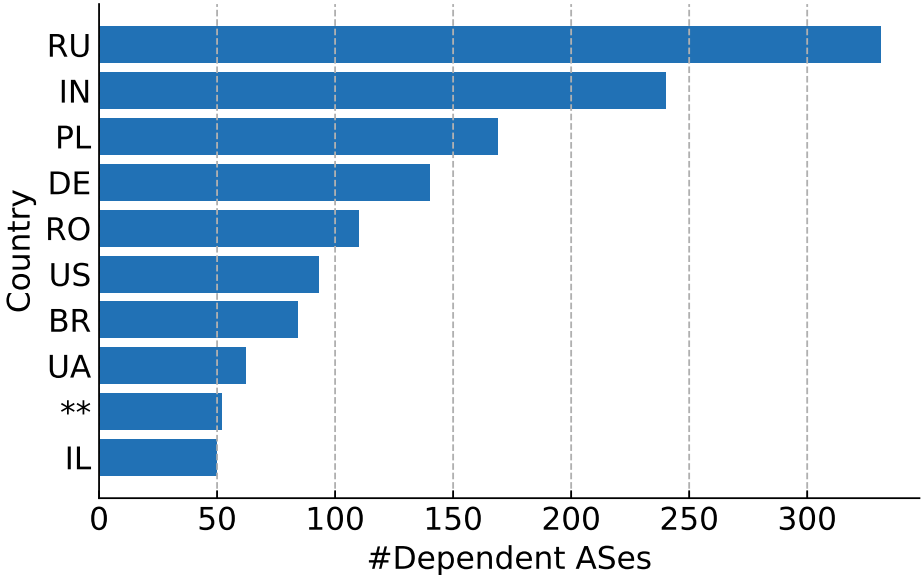
2246 members | 215 dependents

Results — Case Study

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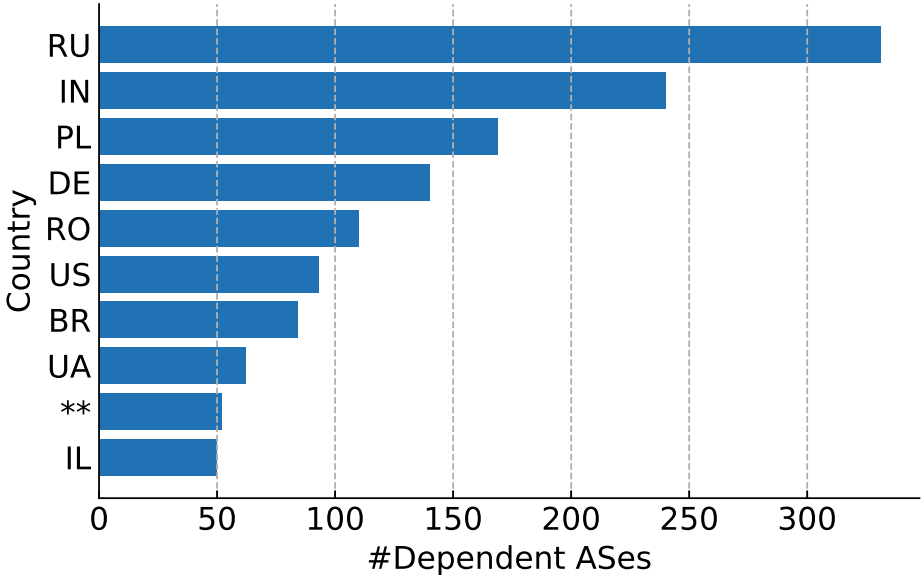
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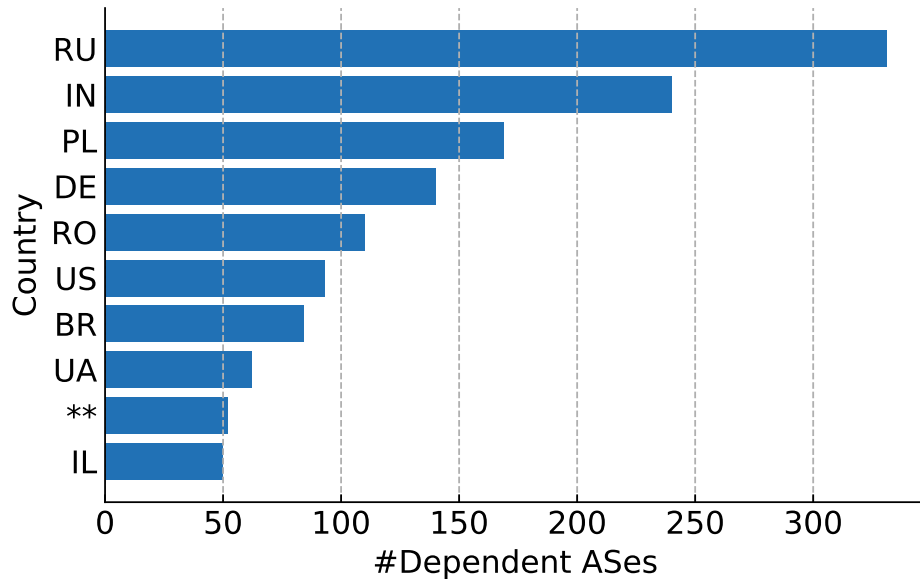
- Dependents in 94 countries
- International

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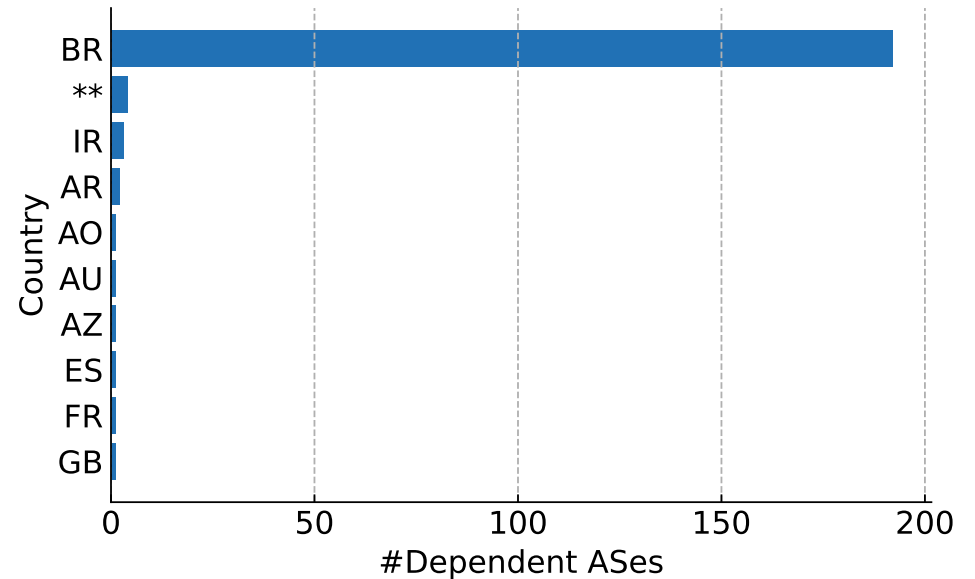
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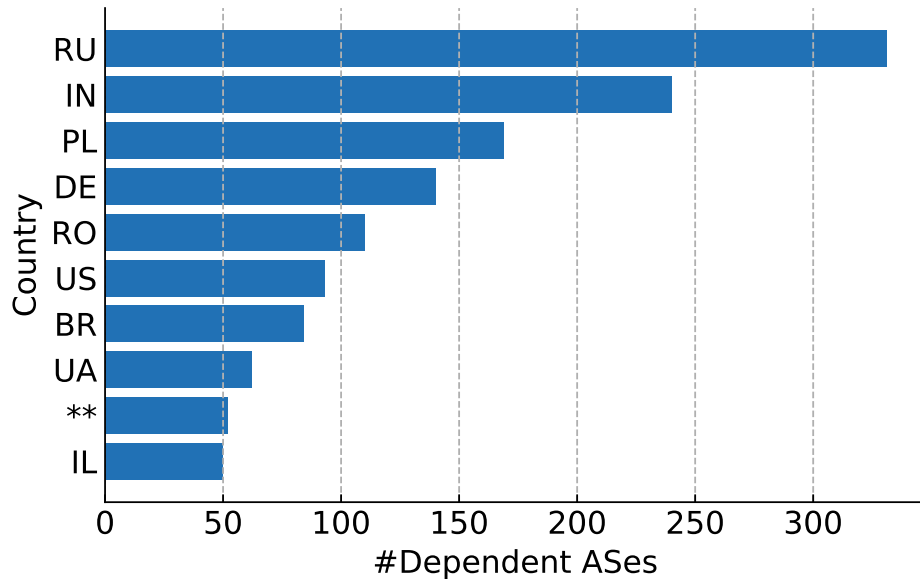
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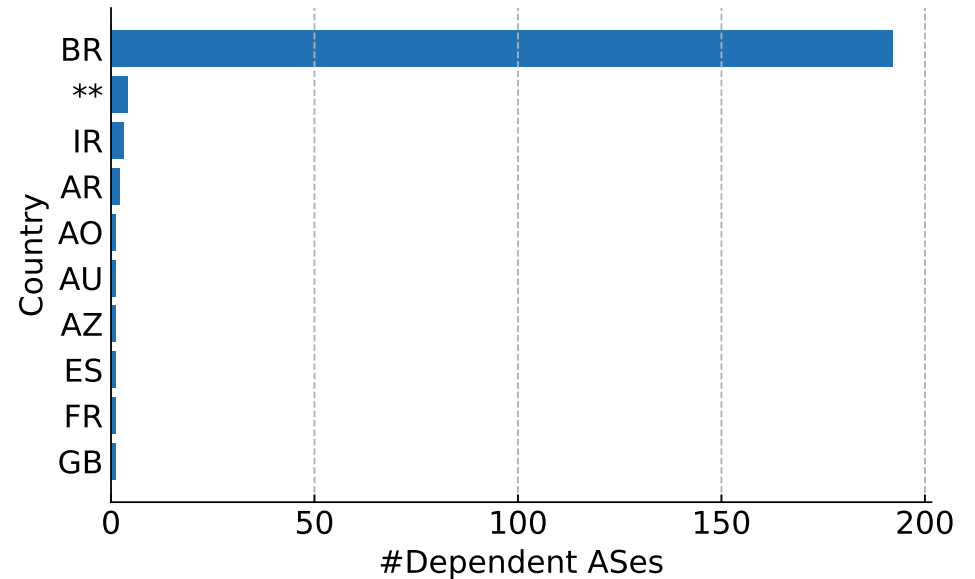
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IX.br São Paulo

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- Dependents in 16 countries
- Regional

Open Data

- Scripts & data to reproduce paper
- Weekly updates of dependency data via API or bulk download

**Following the Data Trail:
An Analysis of IXP Dependencies**

[View reproducibility data](#) [Download CSV data](#) [Access API](#)

This is the accompanying repository for the PAM 2024 paper “Following the Data Trail: An Analysis of IXP Dependencies”. Use the three buttons above to access:

1. Data to reproduce the plots and analysis from the paper.
2. Weekly updated data (in form of CSV files) for bulk data downloads.
3. An API that provides more fine-grained access to the weekly data.

[Data Format \(Archive\)](#)



<https://internethealthreport.github.io/ixp-dependency/>

Conclusion

- Study of IXP dependencies gives insights into the internet topology
- More results in the paper:
 - High-level comparison with BGP
 - Visibility of IXPs in traceroute
 - Member regionality
 - Case study
 - Which members connect dependent networks?
 - Do members share dependents?



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