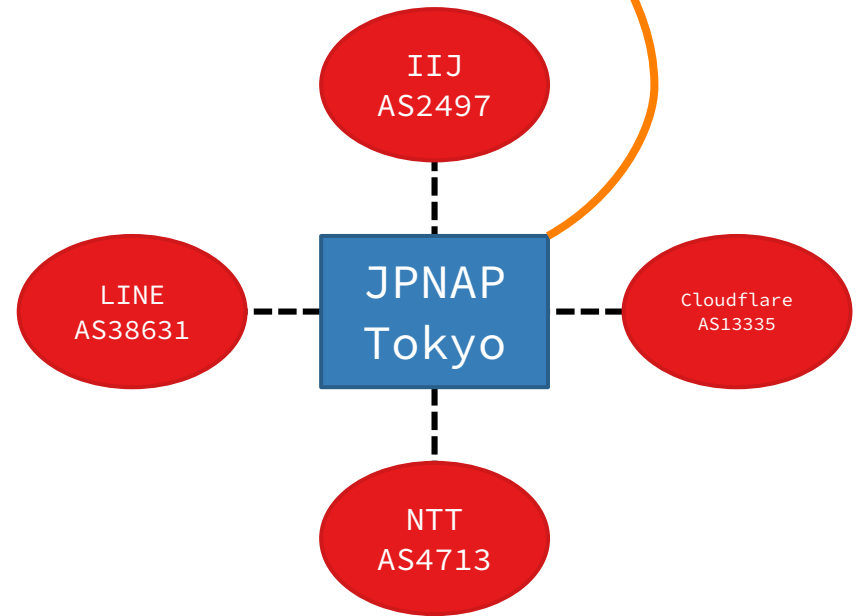# The Past and Present of IXPs

Malte Tashiro

What is an IXP?

- Common ground to connect networks / autonomous systems (ASes)

- Alternative to direct 1:1 connection between networks (private peering)

- Possible advantages
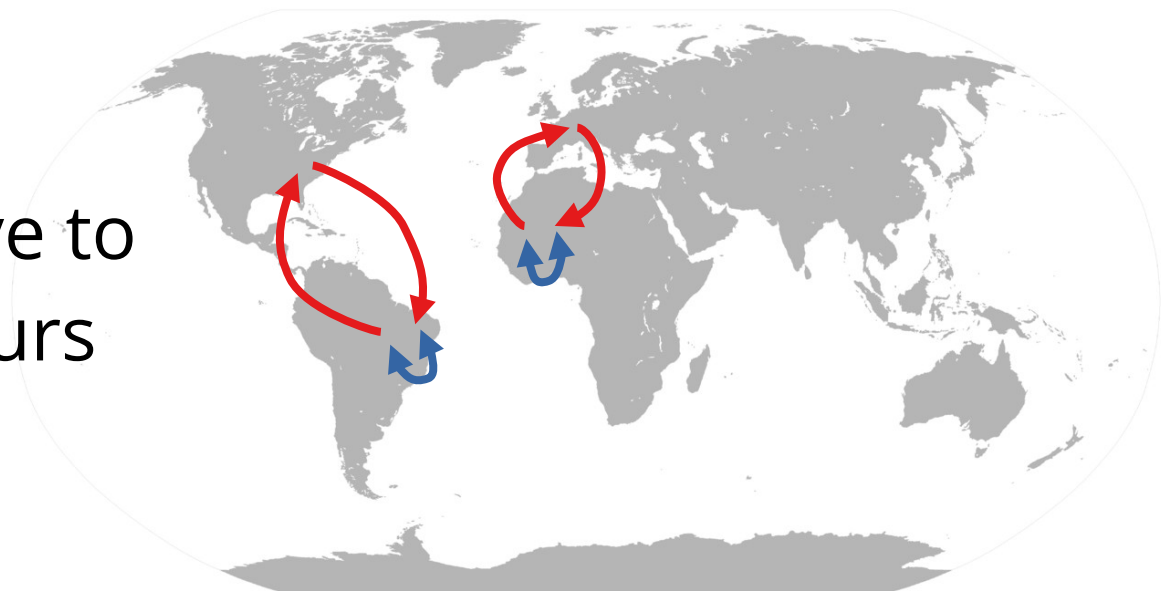 - Reduced cost and latency
  - Improved bandwidth

(not actually JPNAP Tokyo)

Historical Purpose

"Keep local traffic local"[0]

- Regions with poor connections might have to take long routing detours

- Establish regional connectivity instead

[0]N. Chatzis, G. Smaragdakis, A. Feldmann, and W. Willinger, "There is More to IXPs than Meets the Eye," ACM SIGCOMM Computer Communication Review, vol. 43, no. 5, pp. 19–28, 2013.

Why do research on IXPs?

- Part of a larger project on Internet topology

- The Internet is critical infrastructure

  → We ought to understand role of all components

  More knowledge improves the quality of decisions (e.g., where to establish new connections)

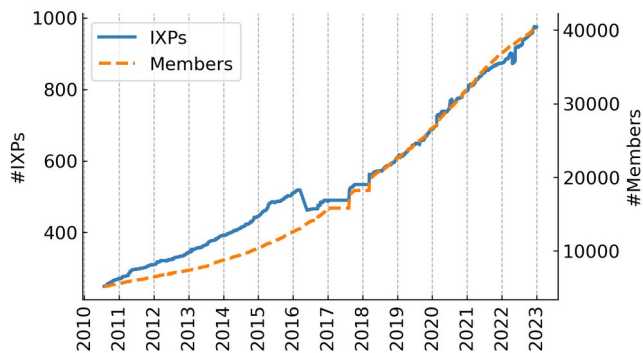- Are IXPs still (only) fulfilling their historical purpose?

PeeringDB

- Database containing peering and IXP information

- One of the go-to sources for IXP information

  - Others: PCH, Euro-IX IXPDB, HE Internet Exchange Report, ...
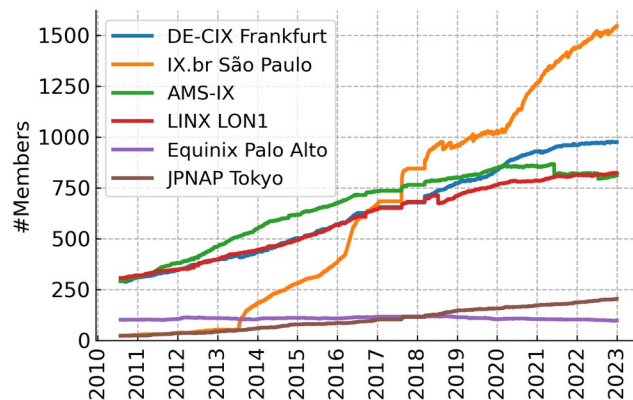
- Why we use it: Historical data available from 6/2010
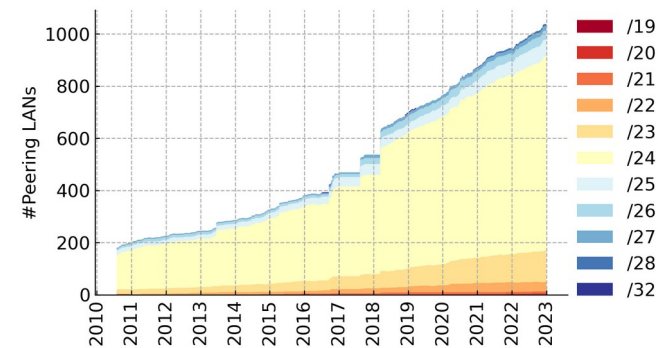
A look at the last 13 years
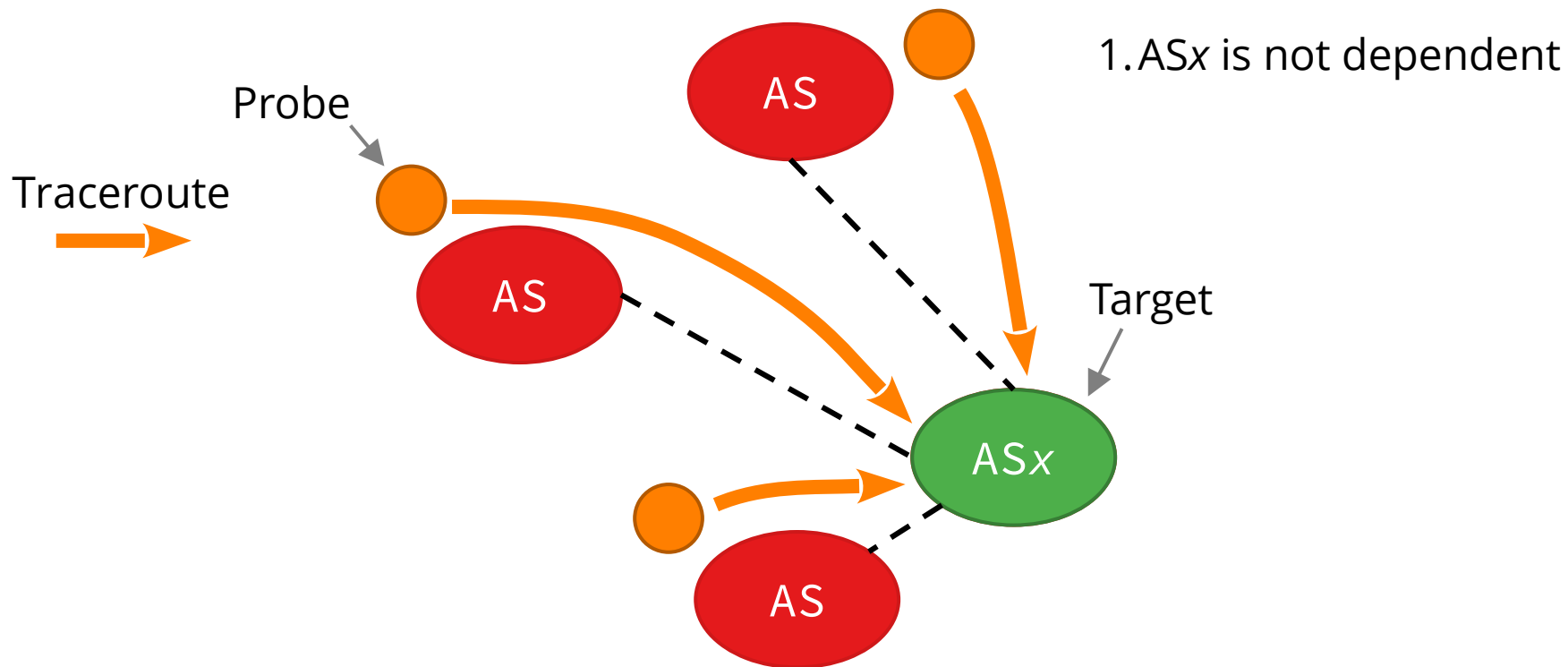
Number of IXPs and members

Member count for selected IXPs

Size of IPv4 peering LANs

Detecting dependencies with traceroute

Probe
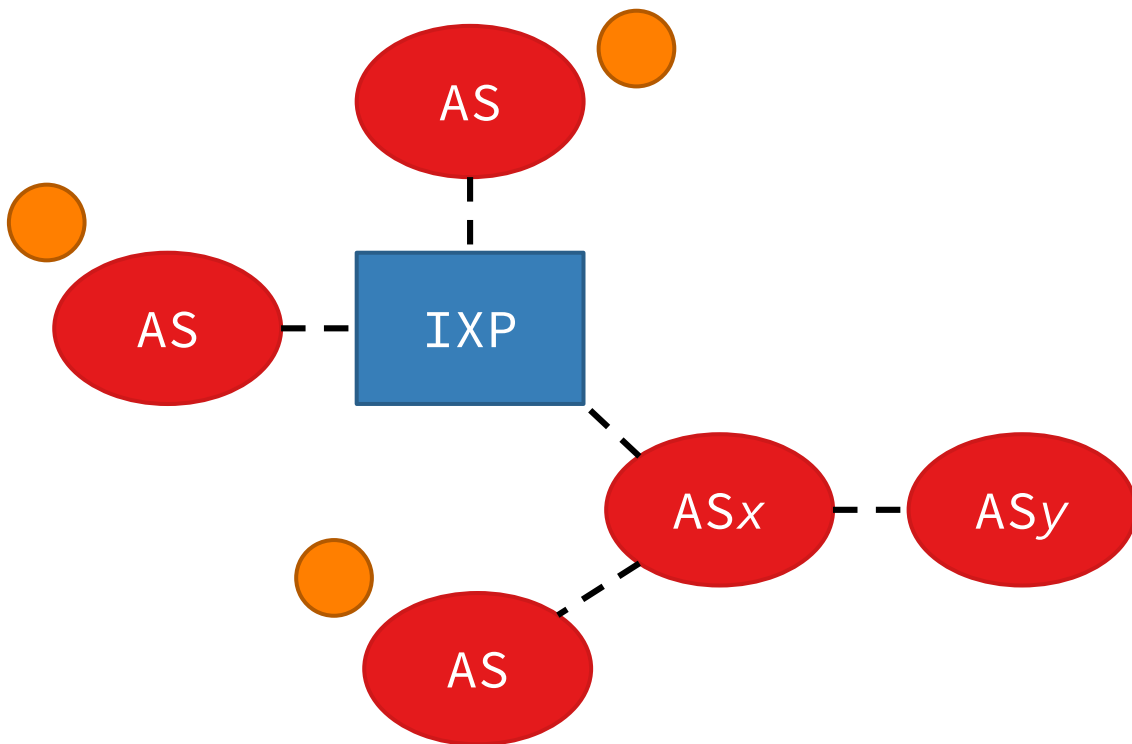
Traceroute

AS

AS

AS

ASx

Target

1. ASx is not dependent

Detecting dependencies with traceroute

1. AS*x* is not dependent
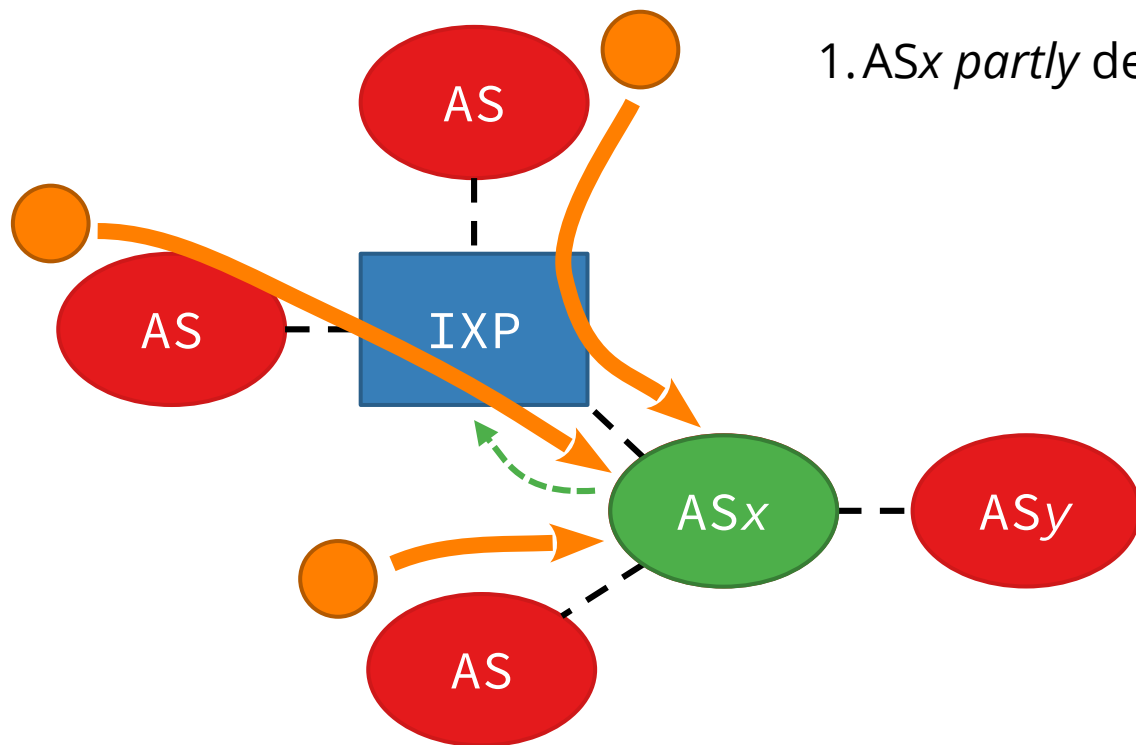2. AS*y* depends on AS*x*

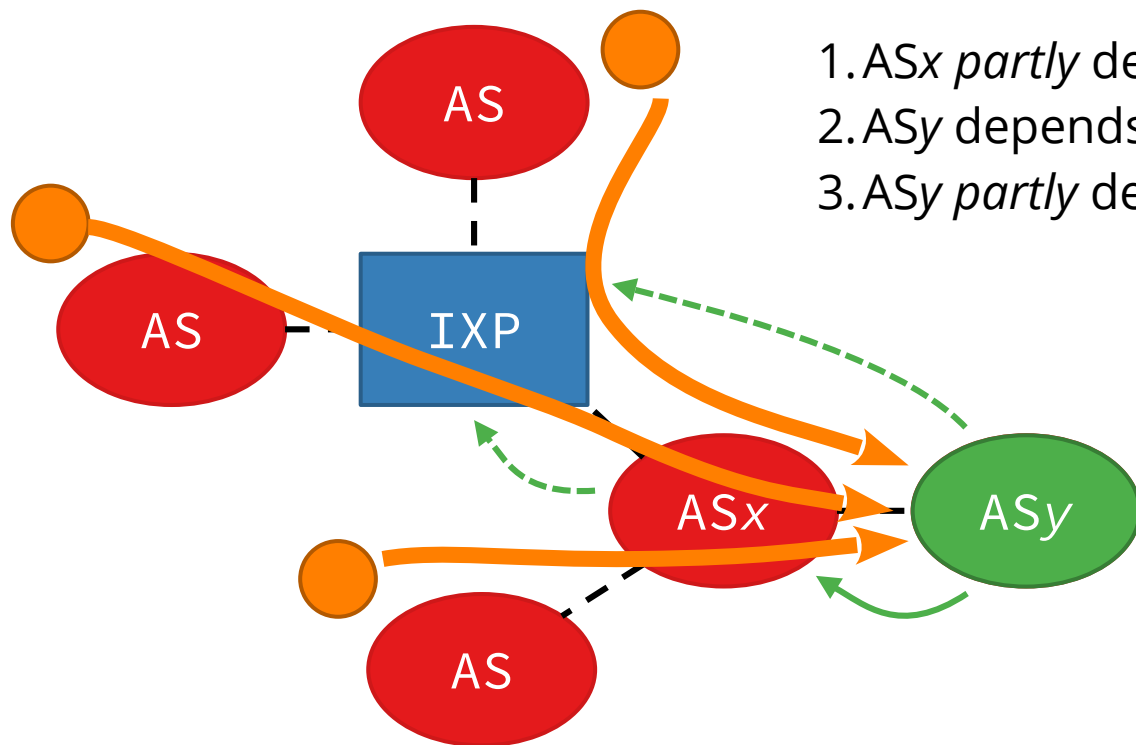# Detecting dependencies with traceroute
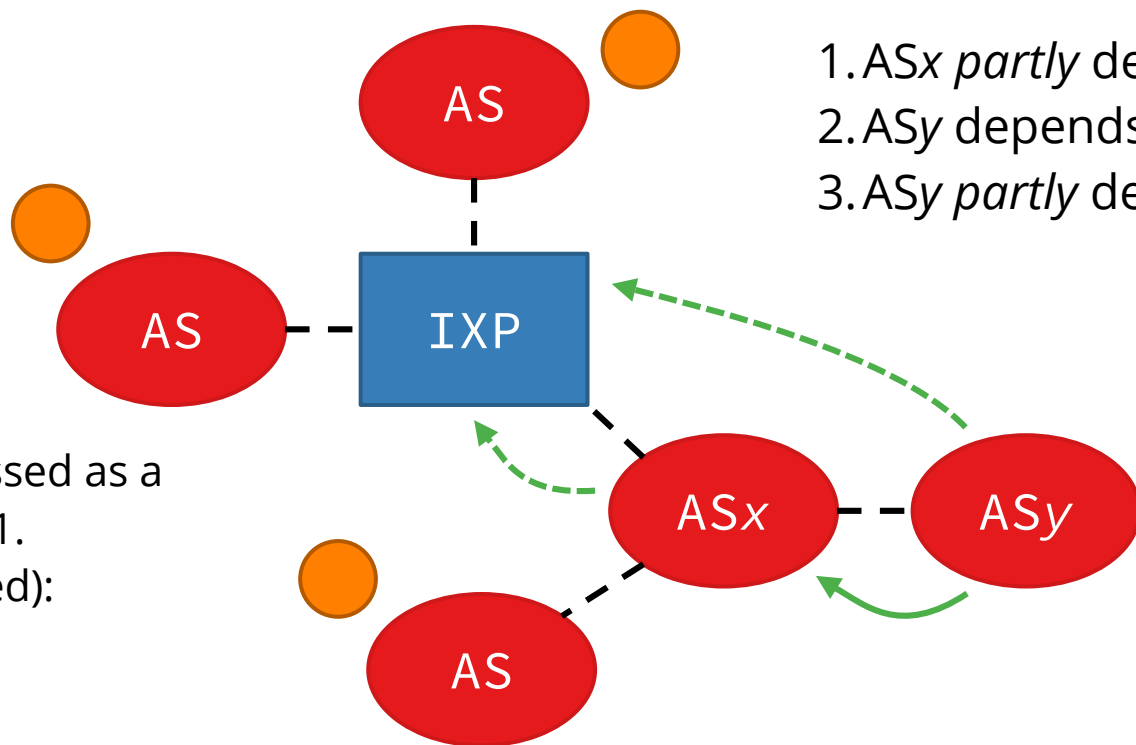
Detecting dependencies with traceroute

1. ASx *partly* depends on the IXP

Detecting dependencies with traceroute

1. AS*x* *partly* depends on the IXP
2. AS*y* depends on AS*x*
3. AS*y* *partly* depends on the IXP

Detecting dependencies with traceroute

1. ASx *partly* depends on the IXP
2. ASy depends on ASx
3. ASy *partly* depends on the IXP

Technical Detail
Dependency is expressed as a value between 0 and 1.
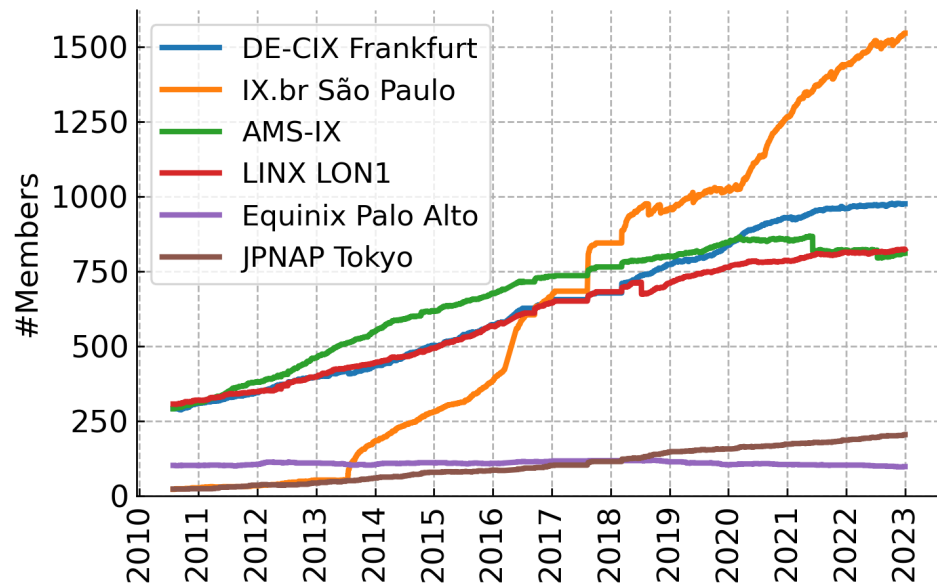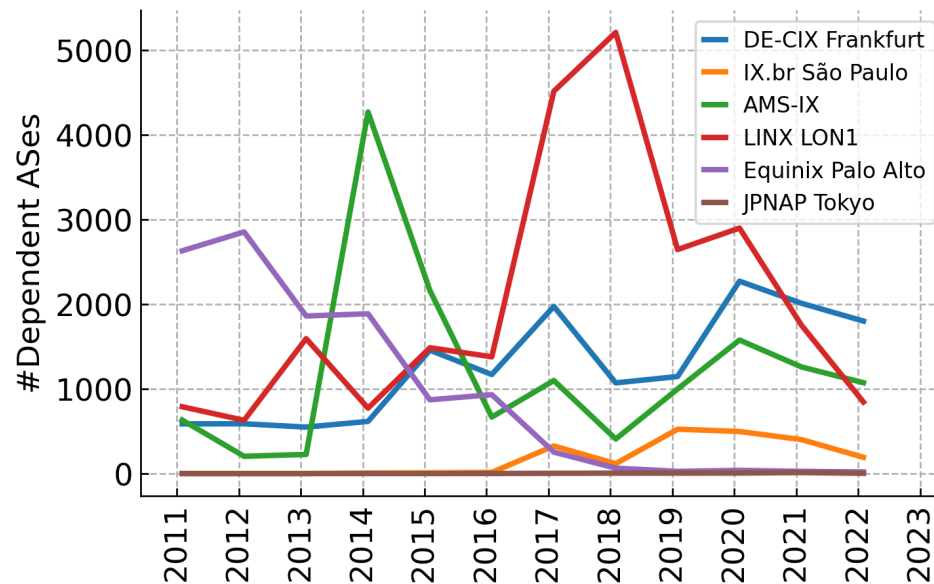For example (simplified):

ASx → IXP ~0.6
ASy → ASx 1.0
ASy → IXP ~0.6

But we will stick to a binary classification (depends, or not) for now.
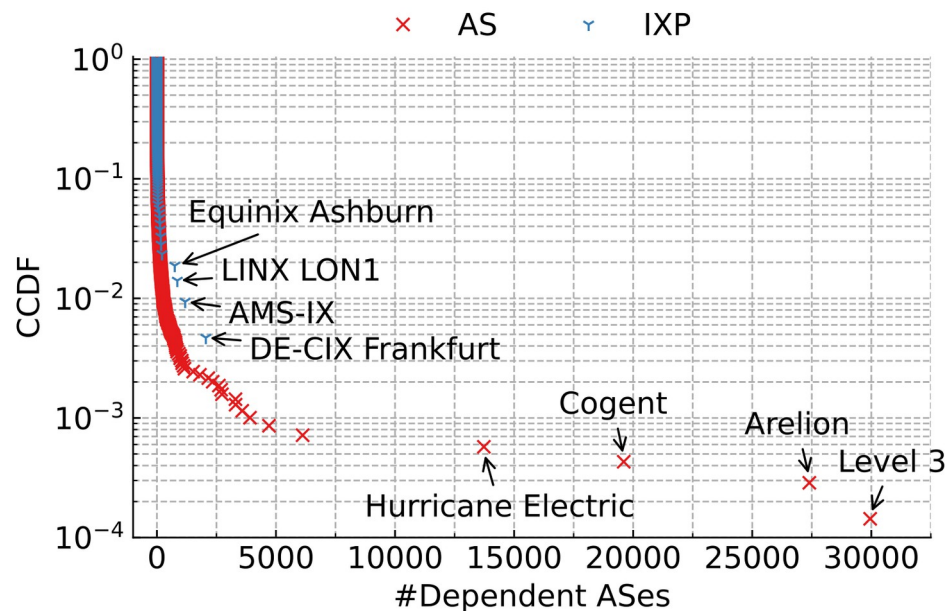
IXP dependencies over the years

IXP member counts

Preliminary!

One datapoint (in January) for each year

IXP (and AS) dependencies in the present

- ASes incur way more dependencies in general

- Some large Tier-1 ISPs stand out

- Same is true for IXPs, but on a smaller scale

Geographic footprint of IXPs

- We can identify the countries of dependent ASes

- Countries of IXP members are already visible in PeeringDB
  - Dependents are deeper in the topology and not obvious

- Dependency analysis gives us a new perspective on the geographic footprint of IXPs

Members

Country A

Country B

Country C

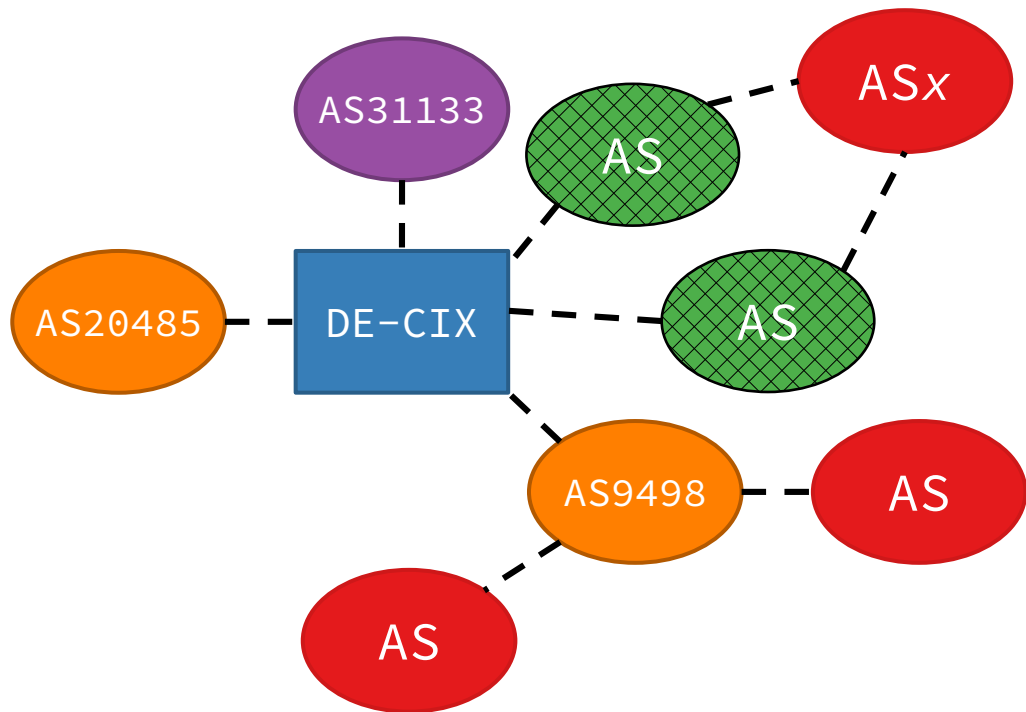(Possible) Dependents
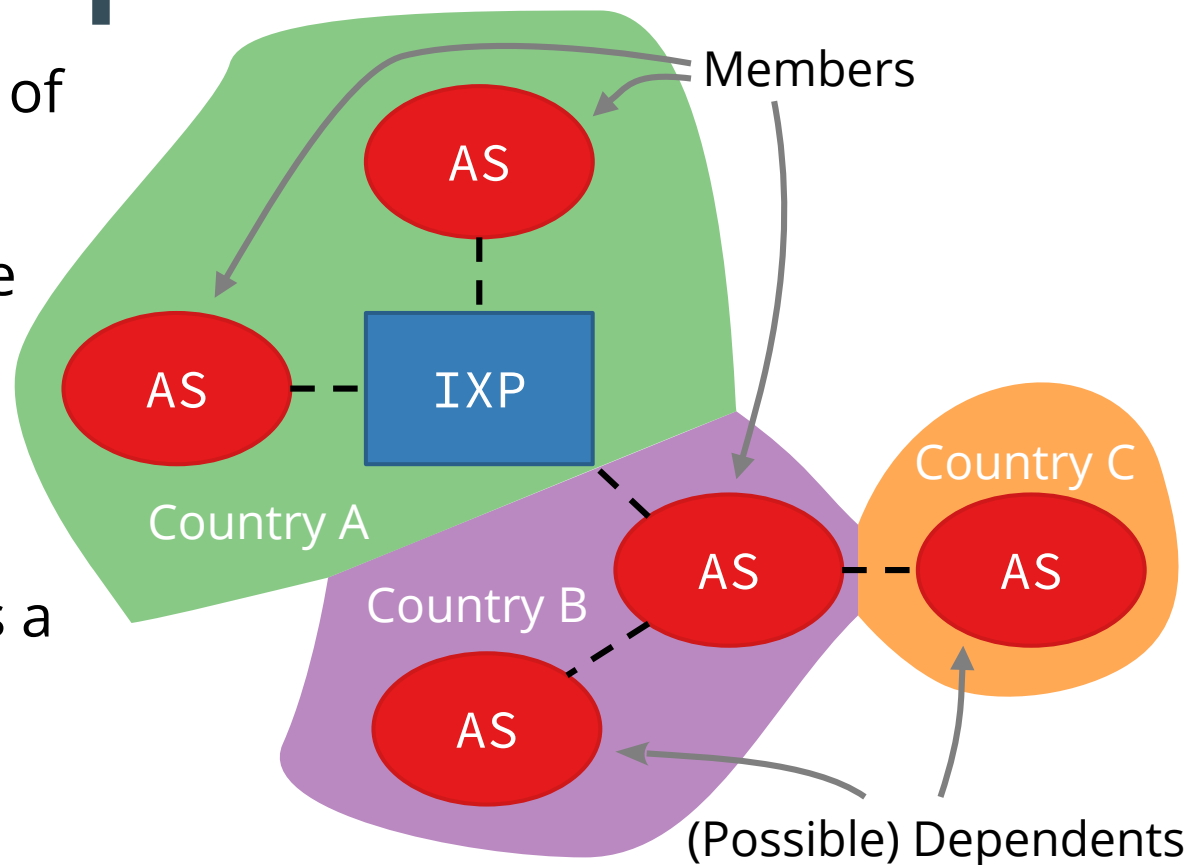
A close look at DE-CIX Frankfurt

- German IXP

- Most dependents **not** in Germany

- Many Russian and Indian ASes are reached via DE-CIX (from our vantage points)
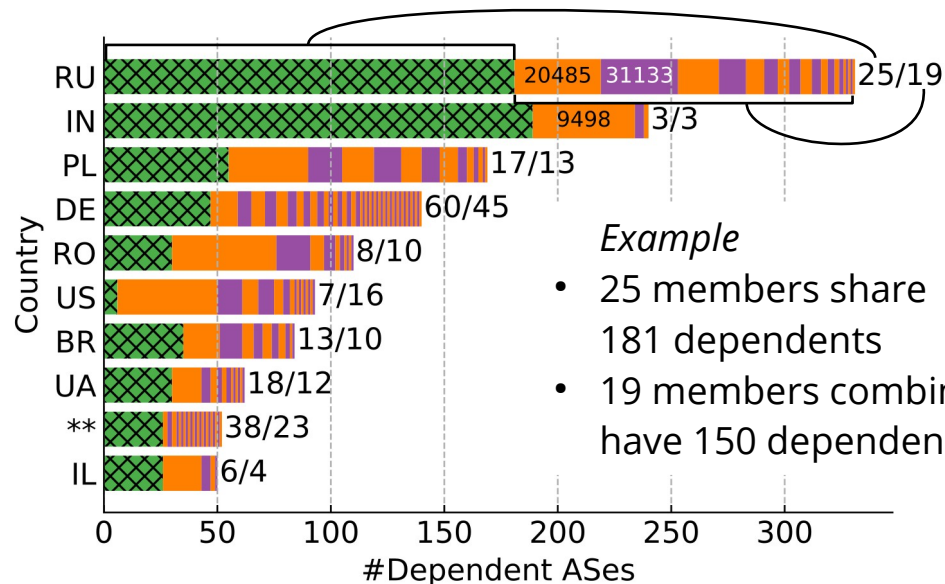
- ** are ASes with presence in multiple countries
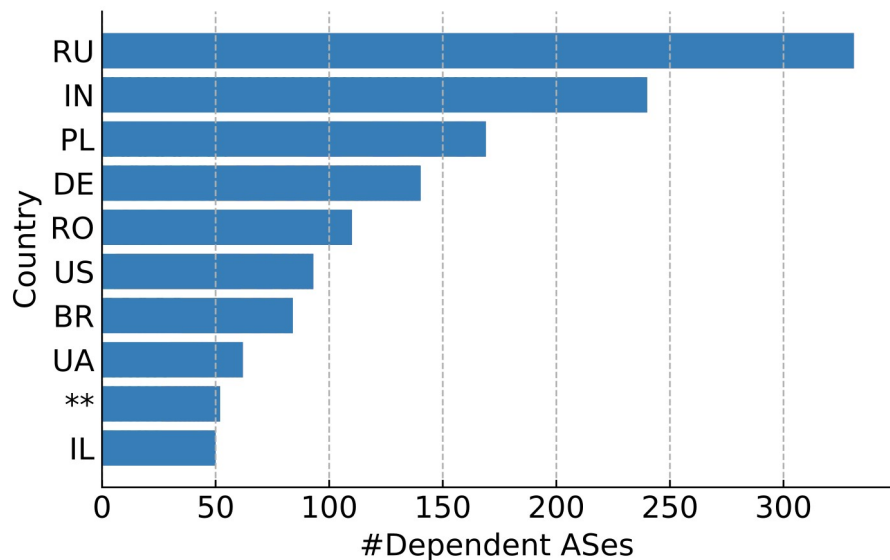
Who connects these dependencies?

A close look at DE-CIX Frankfurt

Regional and global IXPs

IX.br São Paulo
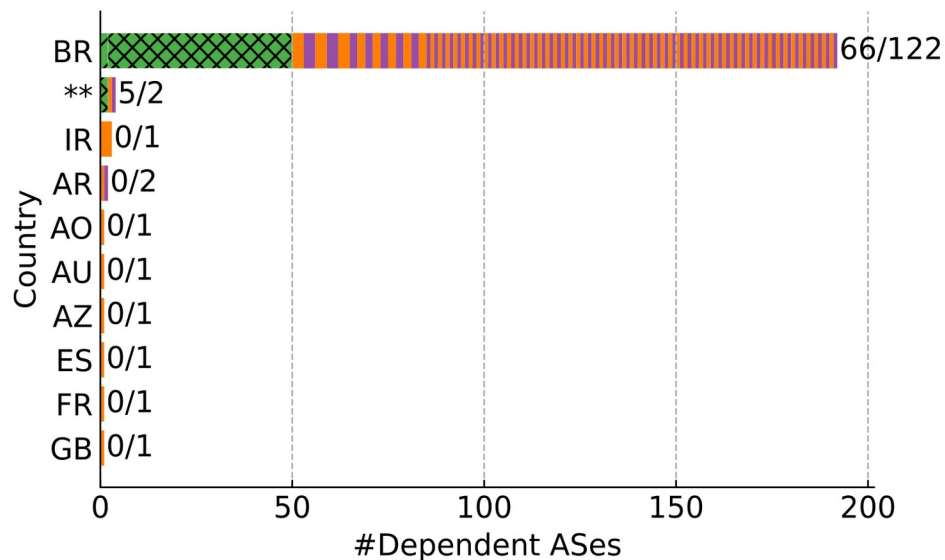
DE-CIX Frankfurt
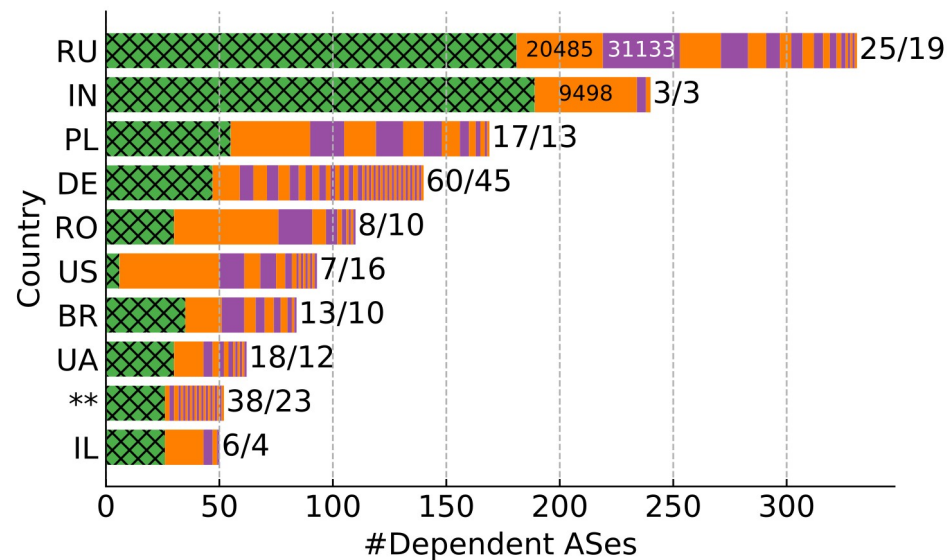
Conclusion

- IXPs keep growing and changing
  - Most are small and regional
  - Some big players are emerging
- Large IXPs do not necessarily incur dependencies
- Some IXPs have grown into international transit hubs
  - Interesting to monitor their role in the future

Image sources

- Slide 3: © User:San Jose / Wikimedia Commons / CC-BY-SA-3.0 / GFDL