



Packet Clearing House

AfPIF 2

PCH Peering Survey 2011

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About PCH

Non profit based in San Francisco, California

Support ‘critical internet infrastructure’

Assist with start-up and growth of IXPs around the globe

Run a large anycast DNS network for ccTLDs - a service offered at no cost to all

Provide a shared DNSSEC hardware signing platform

2011 Peering Survey

The report this presentation is based on, along with future updates, is available at:

<http://pch.net/resources/papers/peering-survey>

2011 Peering Survey

Statistical overview of peering sessions for a research provider - providing input to an OECD paper

- Your ASN *(ASNs stripped after analysis to preserve privacy)*

Data Collected:

- Whether a written and signed peering agreement exists (the alternative being that it's less formal, like a "handshake agreement")
- Whether the terms are roughly symmetric (the alternative being that it describes an agreement with different terms for each of the two parties, like one paying the other, or one receiving more or fewer than full customer routes)
- If a jurisdiction of governing law is defined

Background

Internet comprised of ~5,000 ISP or carrier networks
(transit ASes)

The Internet is made of both Transit and Peering
relationships

Peering allows carriers to exchange traffic bound for
each others' customers

The value-creation engine of the Internet

Background

142,210 interconnections analysed

Responses represented:

- 4,331 different ISP networks - ~86% of the world's Internet carriers
- 96 countries of incorporation
- All 34 OECD countries, 7 / 48 of the UN Least Developed Countries

Background

In 1,032 cases, both parties to the same agreement responded

In **99.52%** of those cases, both parties' responses were identical

This demonstrates that respondents understood the questions clearly

Response by Country

Largest networks represented in dataset:

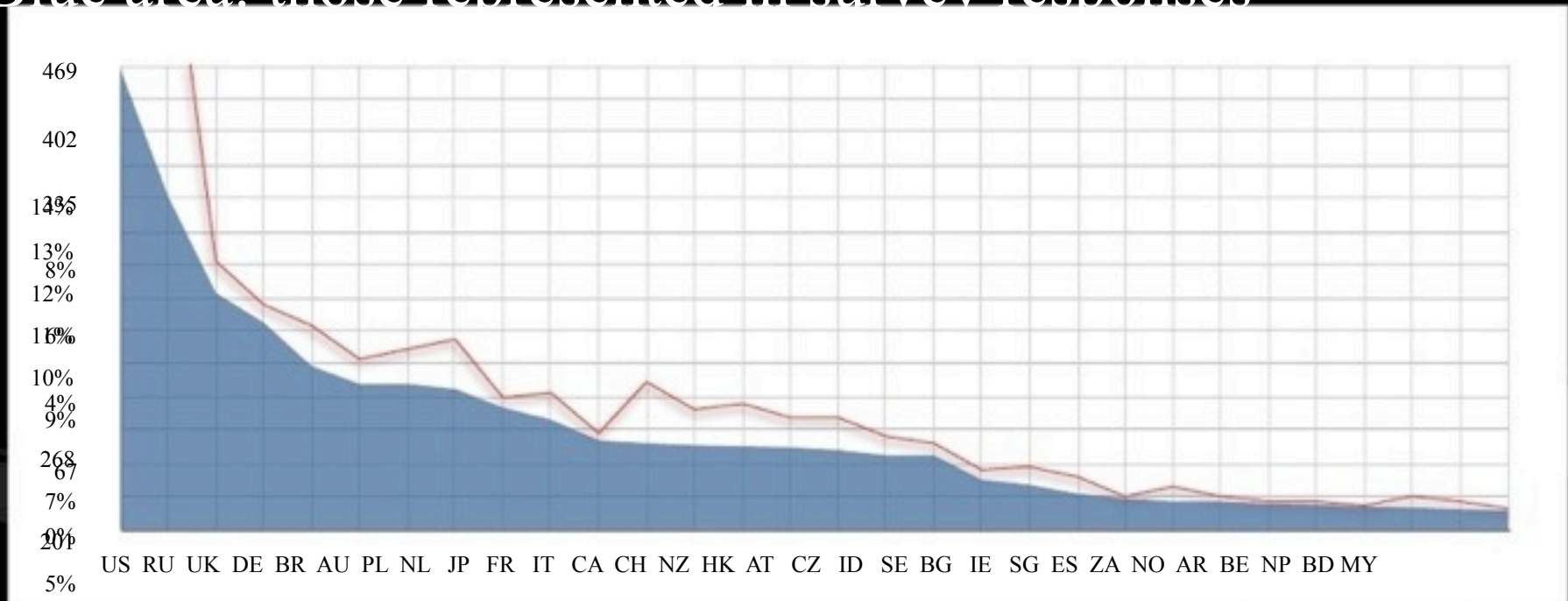
- United States (486)
- Russia (337)
- United Kingdom (239)
- Germany (209)
- Brazil (165)

Nearly half (45) of all countries represented three networks or less

Response by Country

Red line: total networks incorporated in each country

Blue area: those represented in survey responses



3%

1%

Informal Agreements

698 (0.49%) formalised in written contracts

141,512 (99.51%) “handshake” agreements based on informal or commonly understood terms

- Only customer routes exchanged
- BGP4 used to exchange those routes
- Each network exercises duty of care to prevent abuse and criminal misuse

Most agreements formed by peering coordinators or interconnection staff at forums such as this

Symmetric Terms

141,836 (99.73%) had symmetric terms

- Each party give and take the same terms

374 (0.27%) had asymmetric terms

- Different terms between two parties
- e.g. one party pays other (“paid peering”)
- Requirement to meet “minimum peering requirements”

Governing Law

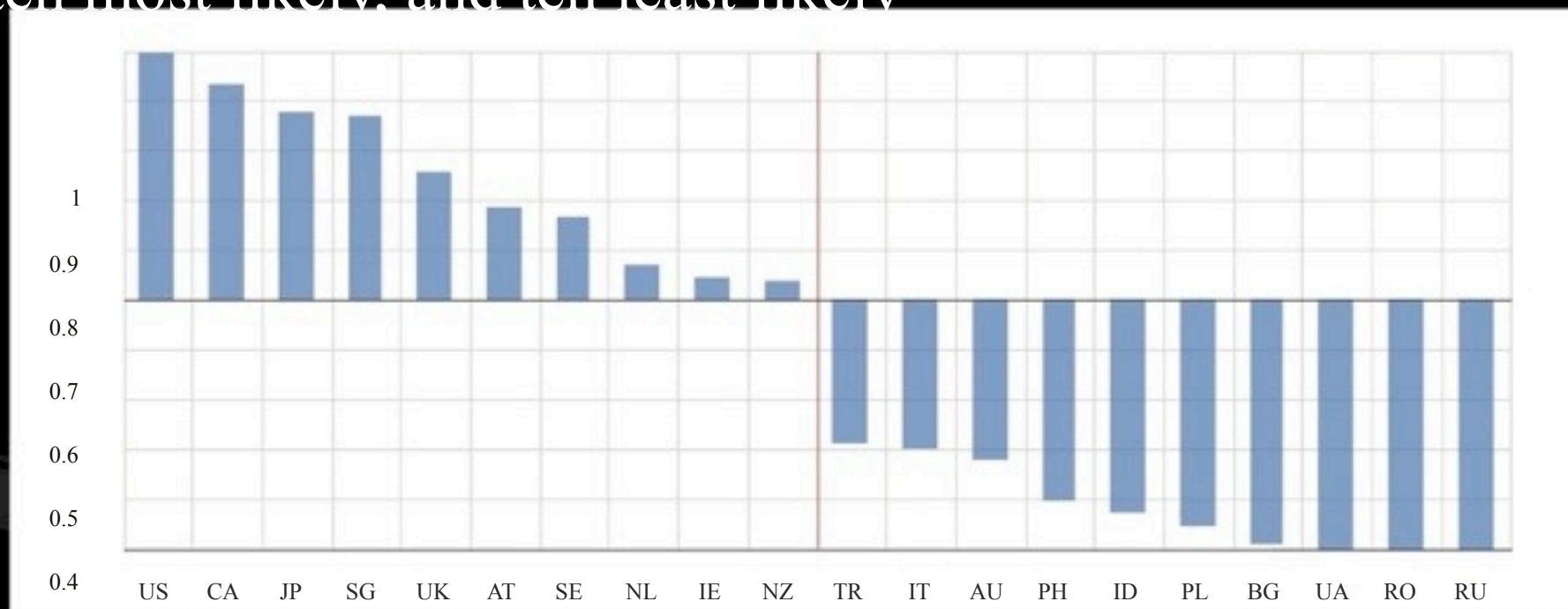
In all cases, the country of governing law was the location of one of the parties' country of incorporation or primary operation

- No country appears to have a compelling rule of law with respect to carrier interconnection

Still a clear preference for country of governing law

Governing Law

Probability of selection as a country of governing law -
ten most likely, and ten least likely



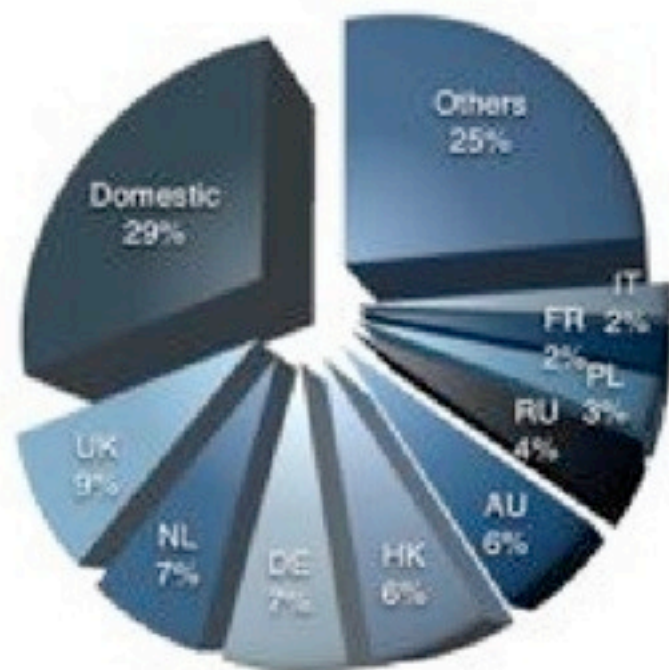
National Interconnection Partners

Looking solely at frequencies with which pairs of countries of incorporation appear...

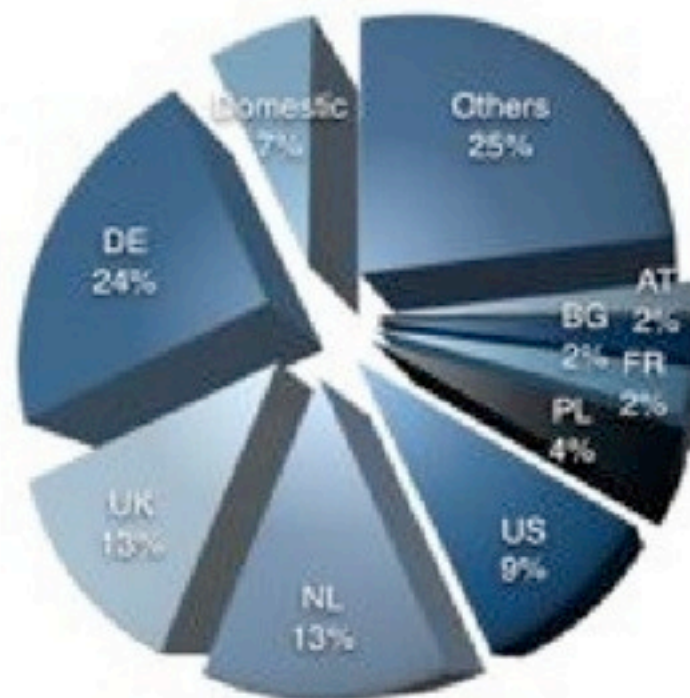
We can chart the relative number of connections between any country and all others

Due to the relatively low proportion of respondents from U.S. and Russian networks, selection bias manifests as a seemingly low number of domestic interconnections in these countries

National Interconnection Partners

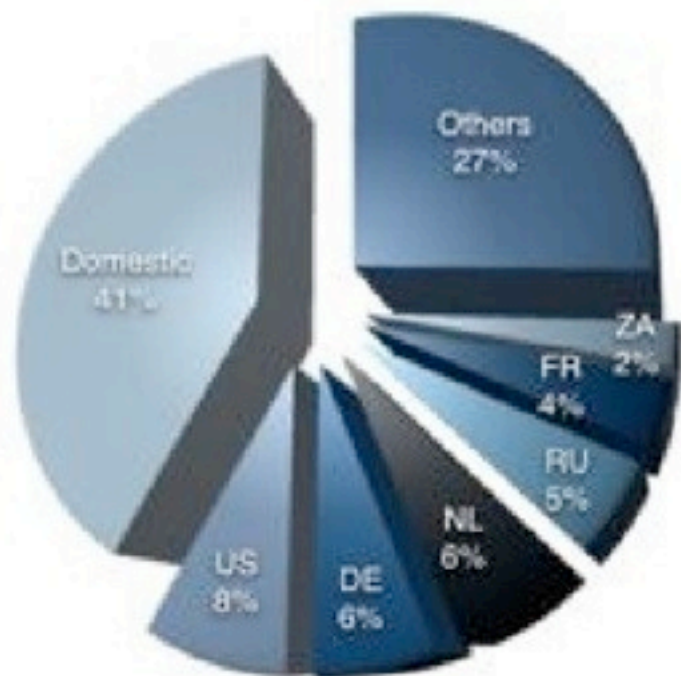


United States

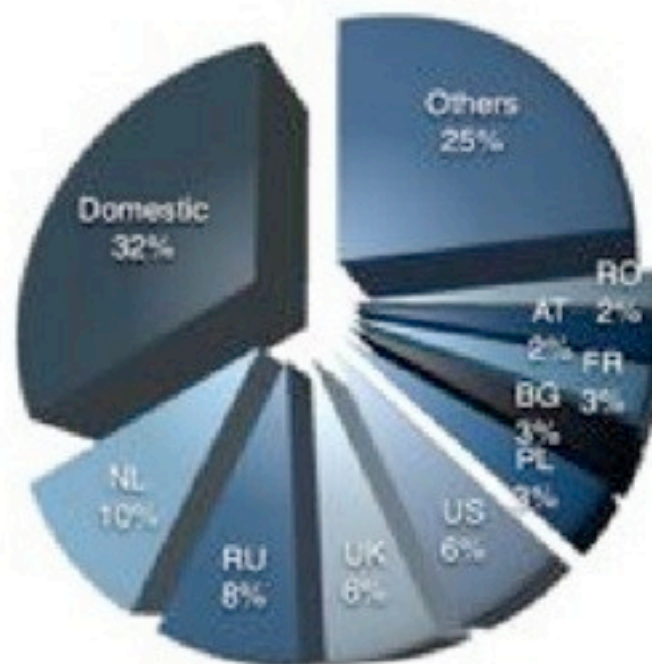


Russia

National Interconnection Partners

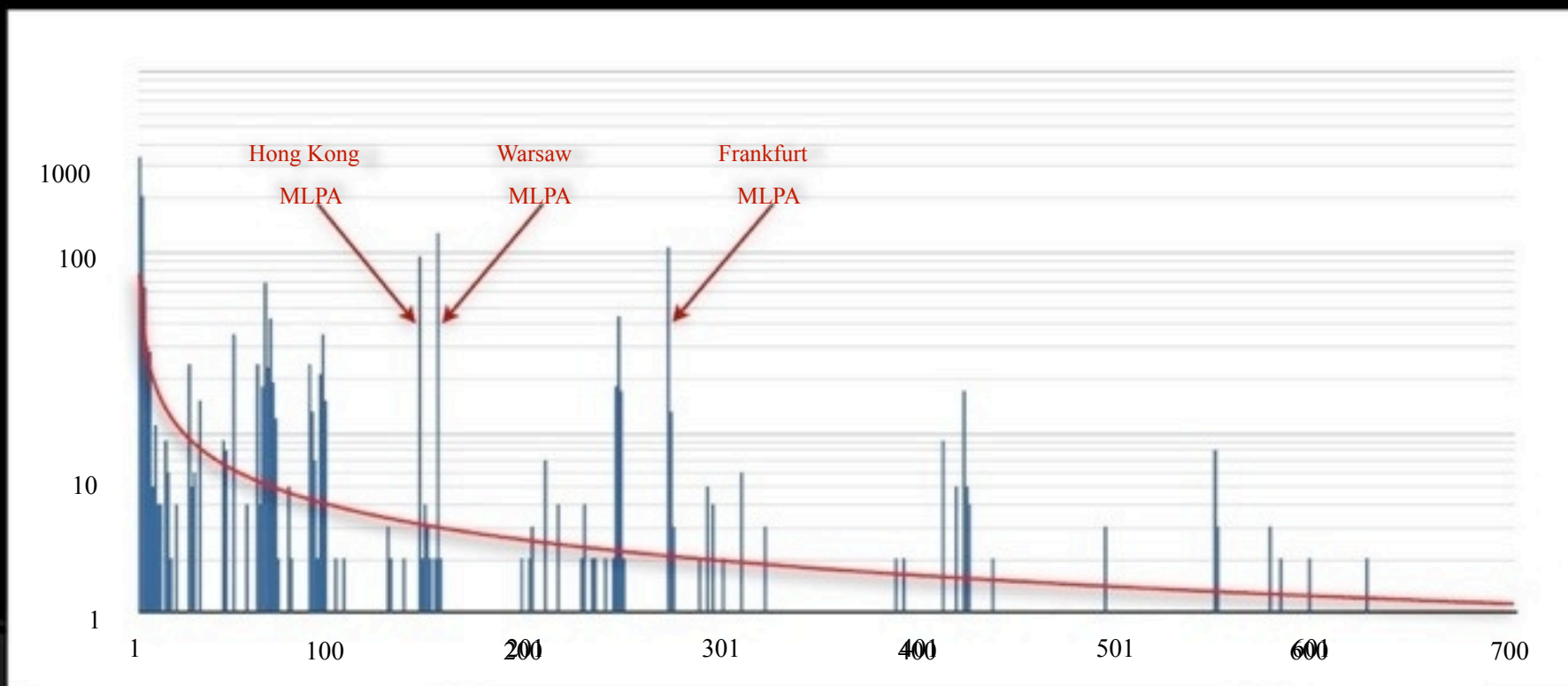


United Kingdom



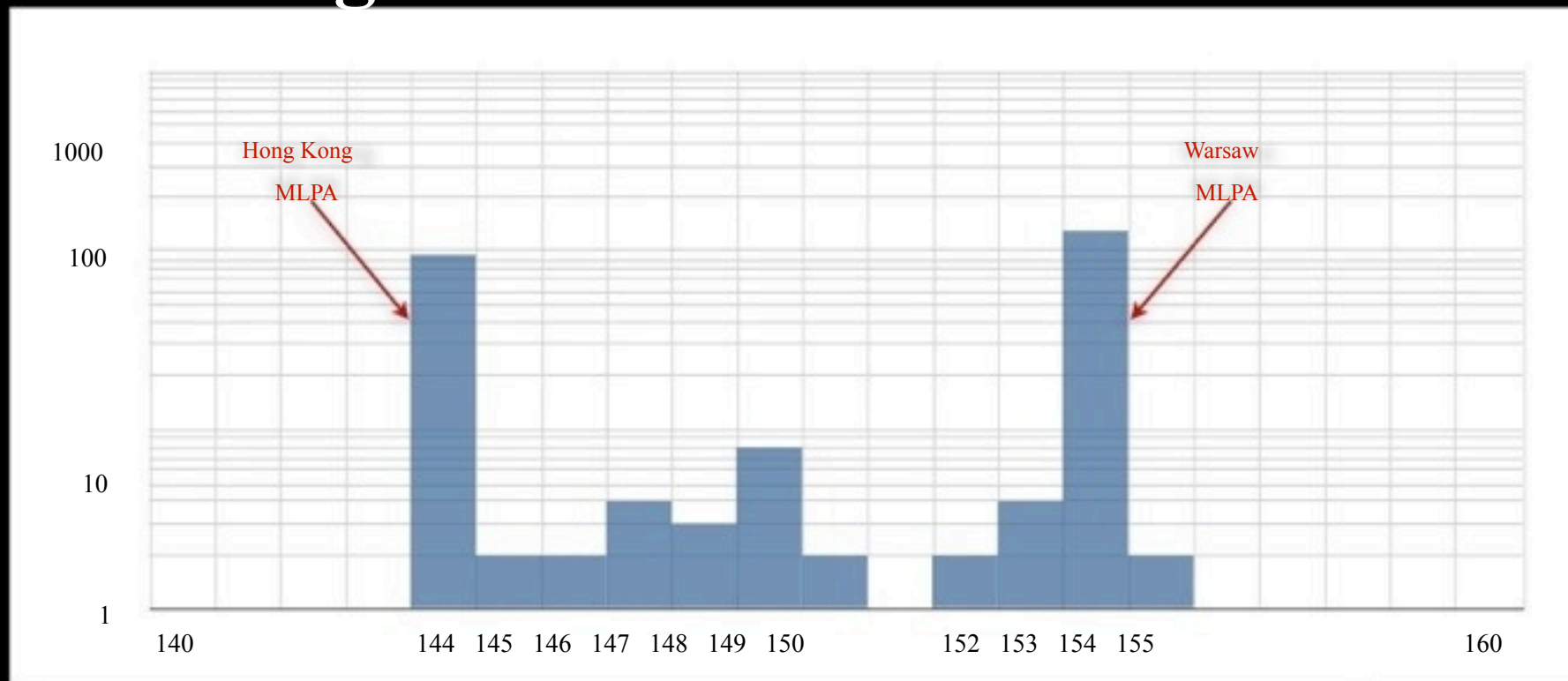
Germany

Degree of Interconnection



Distribution of number of networks (X axis) with each quantity of interconnection partners (Y axis)

Degree of Interconnection



Longer tail after older MLPAs - members have had time to create more bilats

Unexpected Results

Multilateral peering far more prevalent than expected

- Historically thought of as something only smaller networks do

Data collection method doesn't allow for comparison of absolute number of bilateral vs. multilateral, however:

- Majority of AS pairs were connected through MLPA
- Many of these agreements very large - dozens to 100's of participants

Unexpected Results

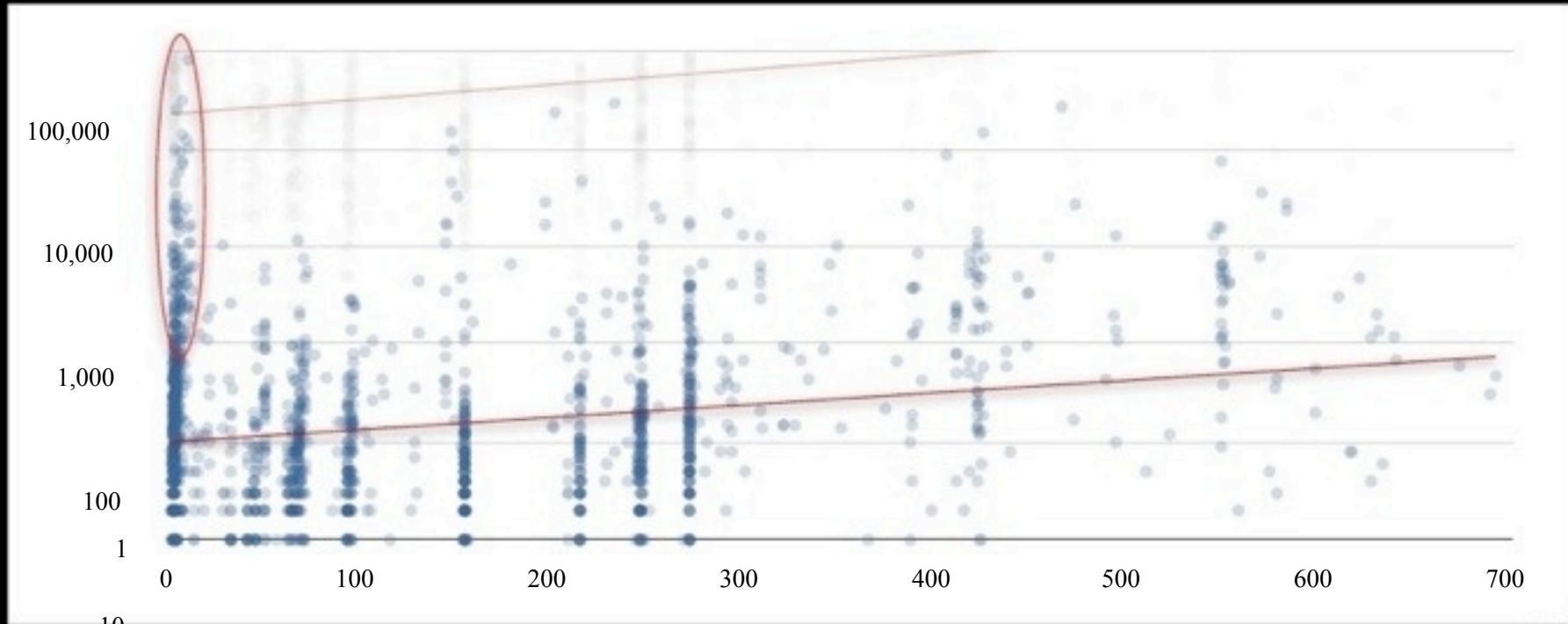
Multilateral peering appears to be taking over bilateral peering - in sheer numbers, even if not in volume of traffic

Multilateral peering no longer something on the periphery

e.g. Hong Kong Internet Exchange - 144 participants

- 10,296 AS-pair adjacencies
- *Each* of these participants individually exceeds the degree of interconnection of the 'tier-1' carriers

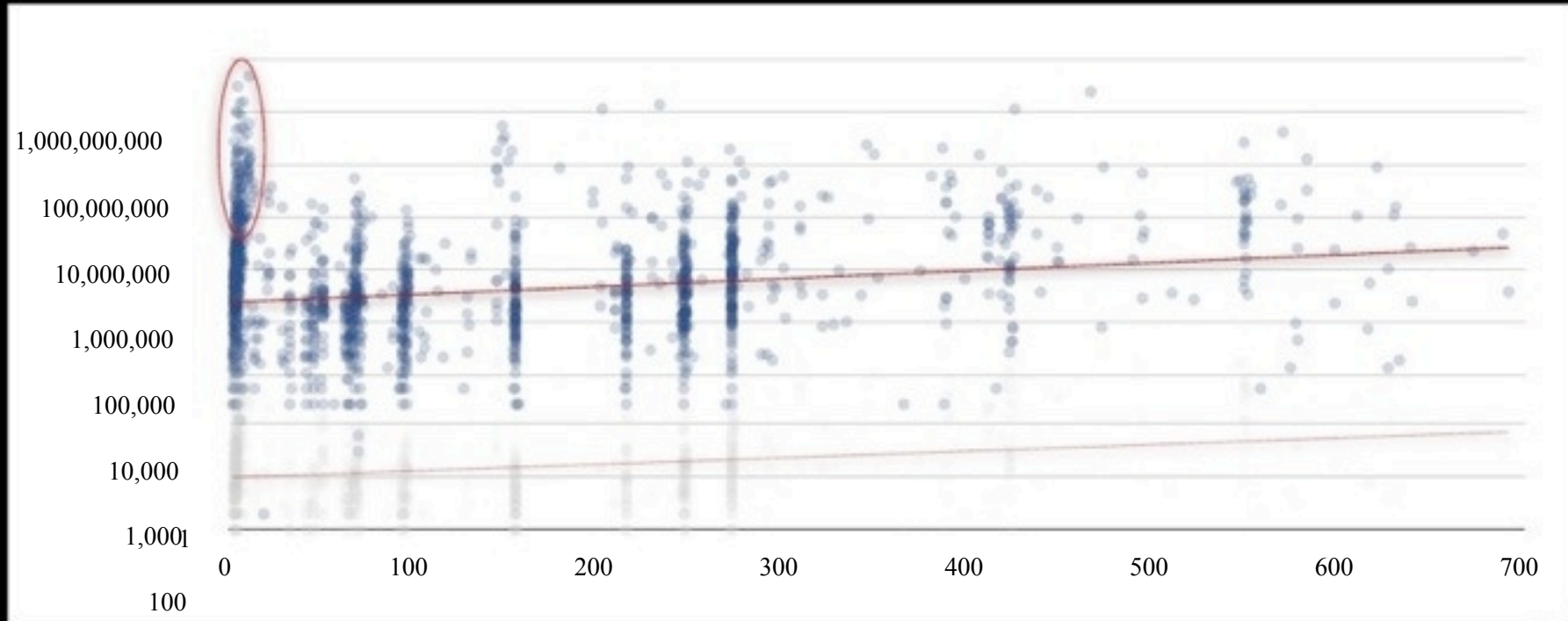
Advertised Prefixes



Number of advertised prefixes (Y axis) over number of interconnection partners (X axis) per carrier

“Tier-1” carriers advertising many prefixes, but
interconnecting with a tiny number of ASes

Advertised Addresses



Number of advertised IPv4 addresses (Y axis) over number of interconnection partners (X axis) per carrier

“Tier-1” carriers advertising many addresses, but interconnecting with a tiny number of ASes

Tier-1 Connectivity

Extrapolating previous charts - if “tier-1” carriers followed the average correspondence between size and number of interconnection partners, they would have many thousand peers

Large CDNs have similar scale and degree of infrastructure investment yet tend to display very broad interconnectivity in both absolute numbers and geographic diversity

An expected result, but far more pronounced than anticipated

Future Work

Relatively few mechanisms to compare distribution of responses to some objective “ground truth” or pre-existing datasets

Previous studies have been several orders of magnitude more narrowly focused

This survey should become a semi-regular event

Hopefully academics will follow up with further work

Thanks, and Questions?

Copies of this presentation can be found
in Keynote, PDF, QuickTime and PowerPoint formats at:

[http:// www.pch.net / resources / papers](http://www.pch.net/resources/papers)

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