

# **2016 Survey of Internet Carrier Interconnection Agreements**

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Packet Clearing House  
February 6, 2017**

# PCH Peering Survey 2011

Five years ago, PCH conducted the first-ever broad survey of Internet peering agreements.

We asked ISPs to tell us three things about each of their peering agreements:

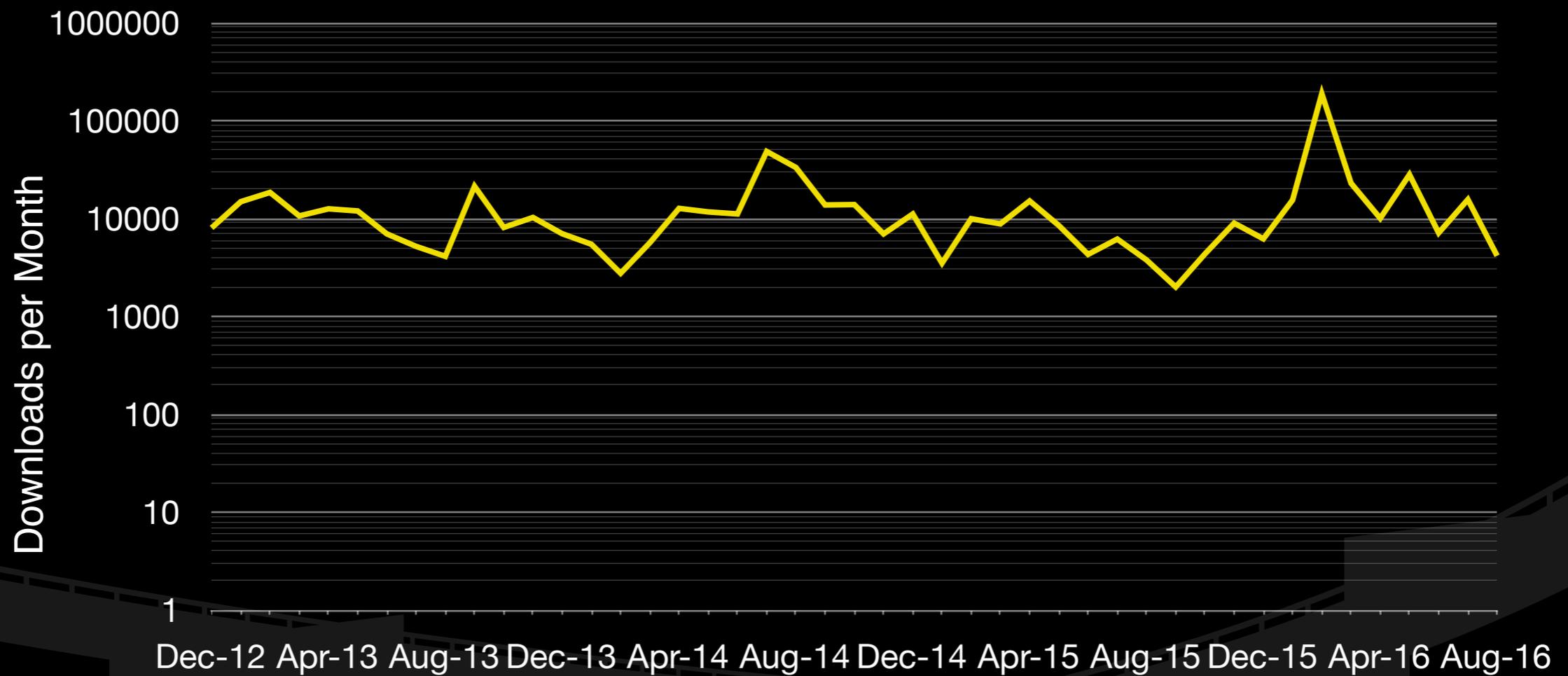
- Is the agreement formalized in a written document, or is it a “handshake” agreement?
- Does the agreement have symmetric terms, or do the parties exchange different things?
- What is the country of governing law of the agreement?

# PCH Peering Survey 2011

The previous largest survey analyzed sixteen agreements, all in the United States. In 2011 we analyzed 142,210 agreements from 4,331 Internet service provider networks in 96 countries.

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

# The 2011 report has been downloaded more than 500,000 times in five years



In 2011, we promised to repeat the survey every five years, in order to document trends in the industry and begin building time-series data.



*“The PCH peering survey provides a unique insight into why the Internet’s model of traffic exchange has been so successful around the world. It underlines the degree of global uniformity across regulatory regimes that would otherwise not be able to harmonize among themselves. This information is invaluable to our work in providing advice to policy makers.”*

– Dr. Sam Paltridge  
Directorate of Science, Technology and Innovation  
OECD

# PCH Peering Survey 2016

We've now published the results of our 2016 survey.

In addition to the three questions we asked in 2011...

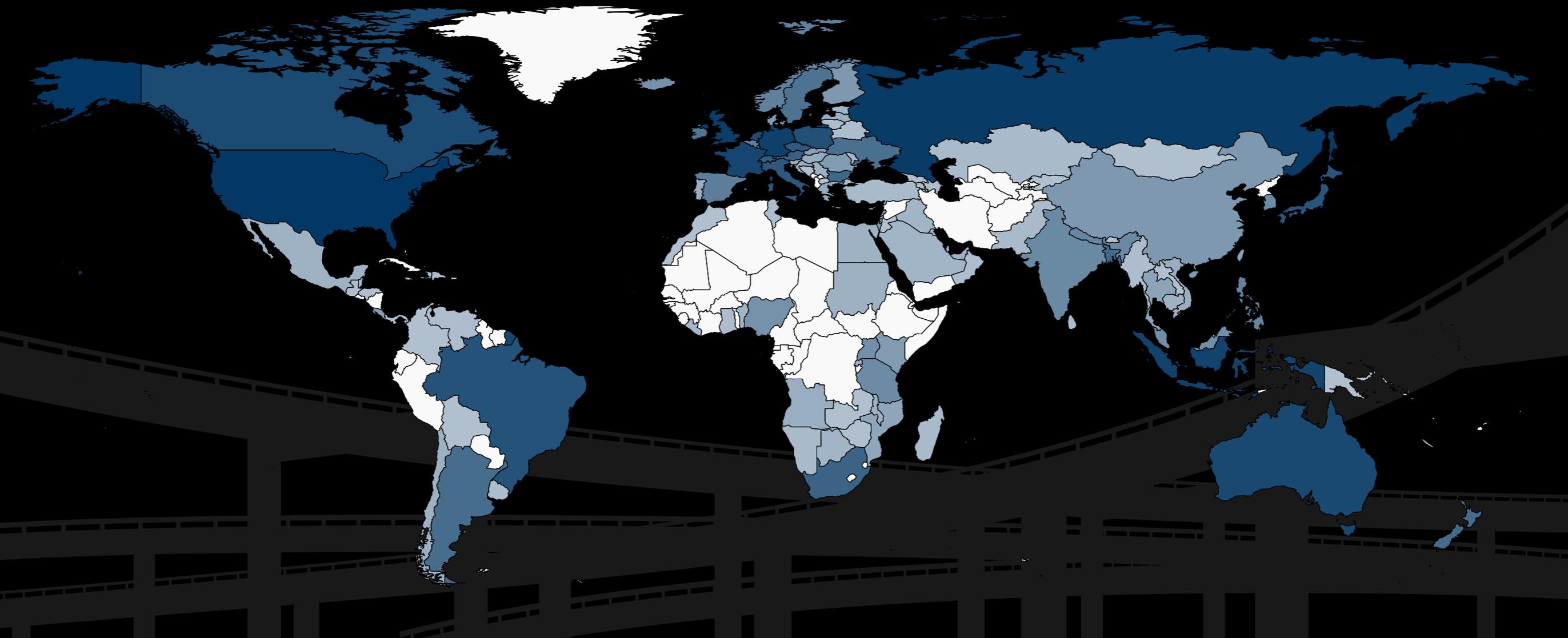
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We added one more question:

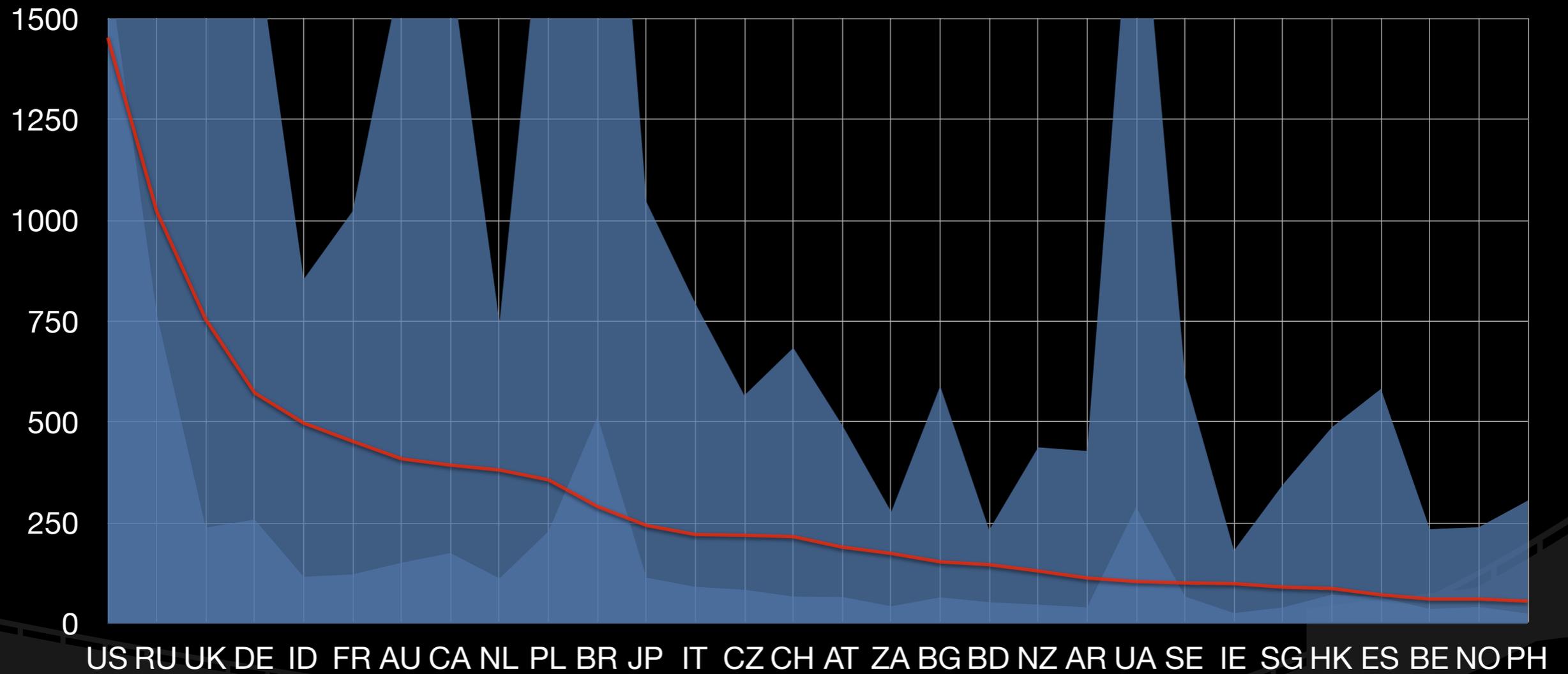
- Are you exchanging IPv6 traffic with this peer?

# PCH Peering Survey 2016

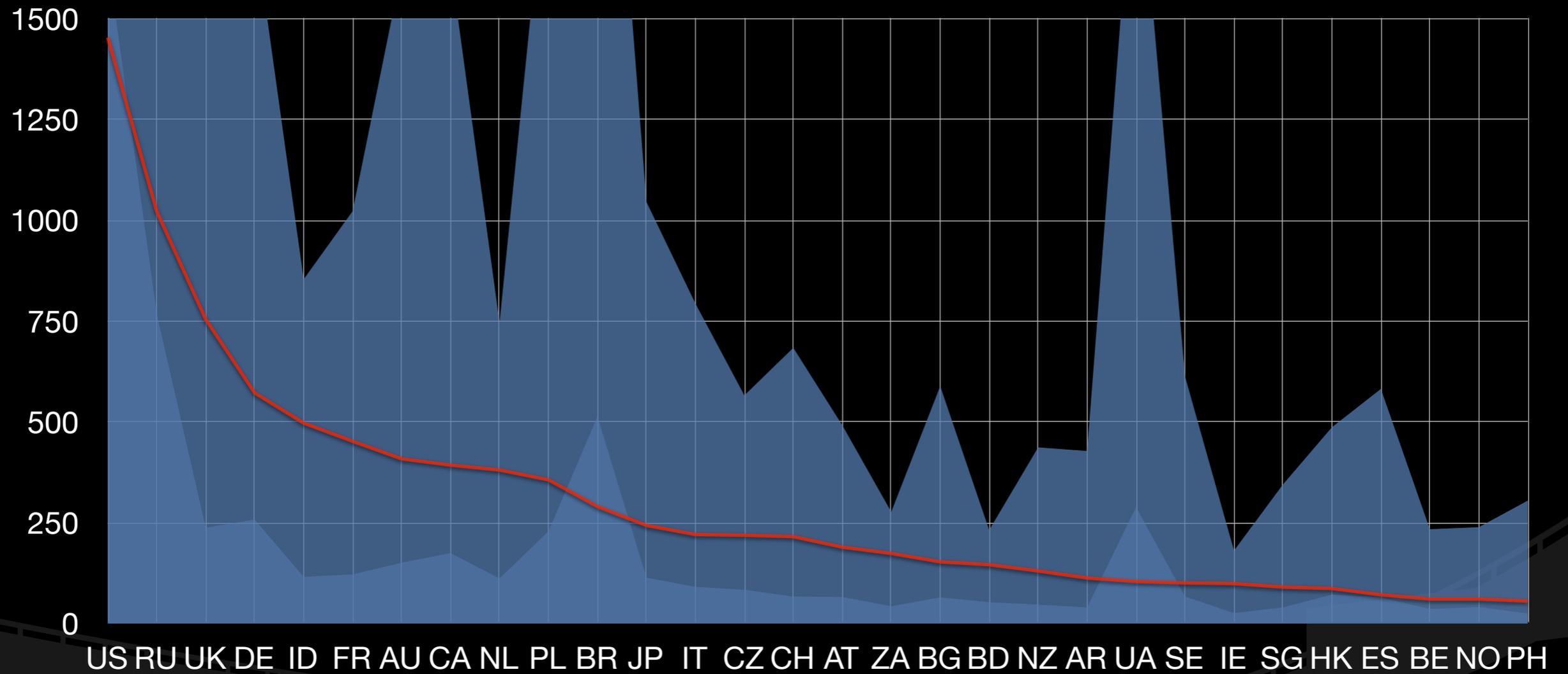
We analyzed 1,935,822 interconnection agreements representing 10,794 carrier networks in 148 countries including all 35 OECD member countries and 21 UN LDCs.



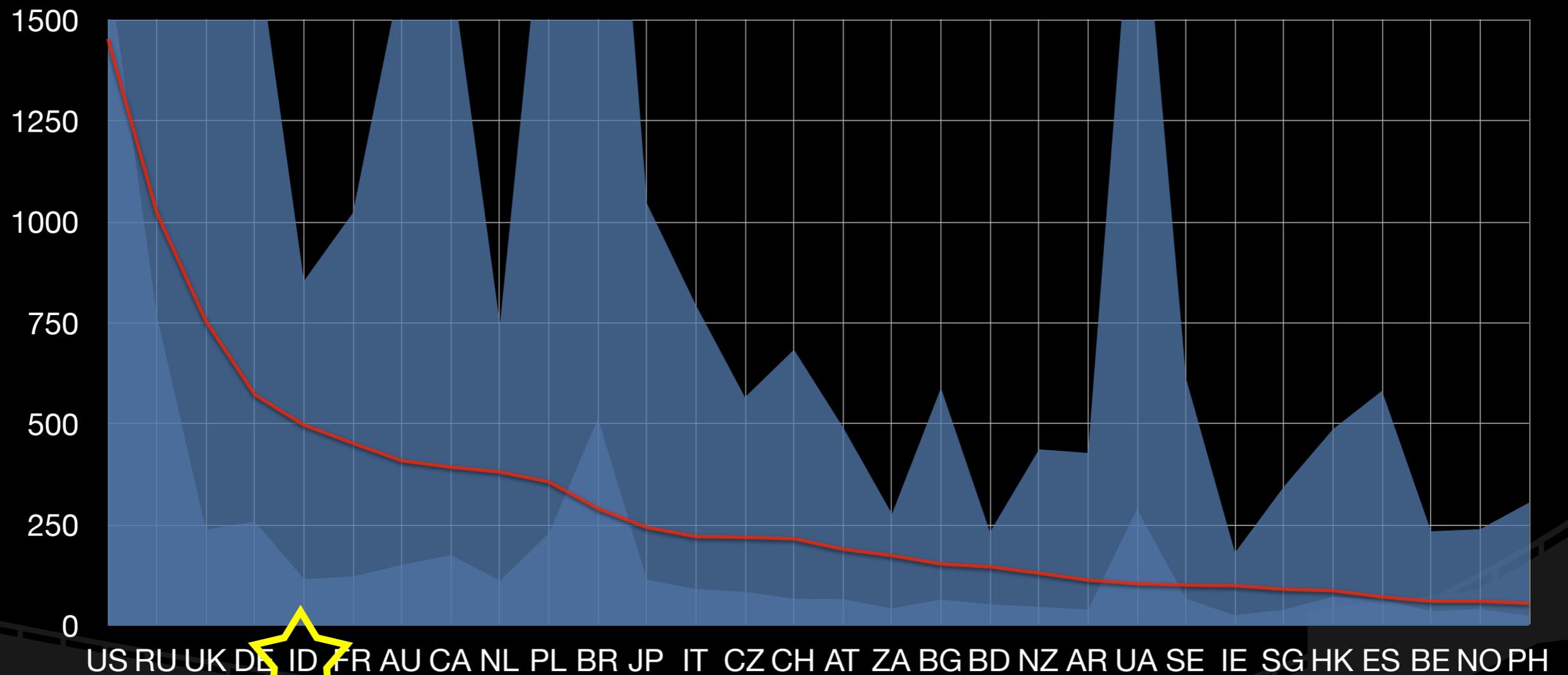
# Proportion of Representation



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Indonesia: The world's fourth largest country by population, and sixteenth largest economy, up from #18 five years ago to #5 today.

# PCH Peering Survey 2016

955,510 of the agreements (49.35% of the total) comprised 477,755 matching pairs, in which both parties to the same agreement responded to our survey, and in 98.71% of those cases, both parties' answers to each of the questions were in agreement.

That's a slight decrease from 99.52% five years ago, and we attribute that to the addition of the IPv6 question. The more questions we ask, the more opportunities exist for disagreement between each pair of answers.

In addition to the survey, we conducted unstructured follow-up interviews with 35 of the responding networks.

# Key Findings

**99.93% of peering agreements are informal “handshake” agreements** in which both parties agree to abide by globally-recognized terms. This is up from 99.51% in 2011. From 1 in 200 then to 1 in 1,400 today.

This finding was not thrown off by unrepresentational participation: essentially all major backbone providers are represented in the dataset.

Follow-up interviews with holders of written contracts indicated that, while the contracts are being allowed to expire, the relationships they formalized continue to grow.

# Key Findings

**99.98% of peering agreements had symmetric terms** in which each party gave and received the same conditions as the other. This is up from 99.73% in 2011. From 1 in 400 then to 1 in 4,800 today.

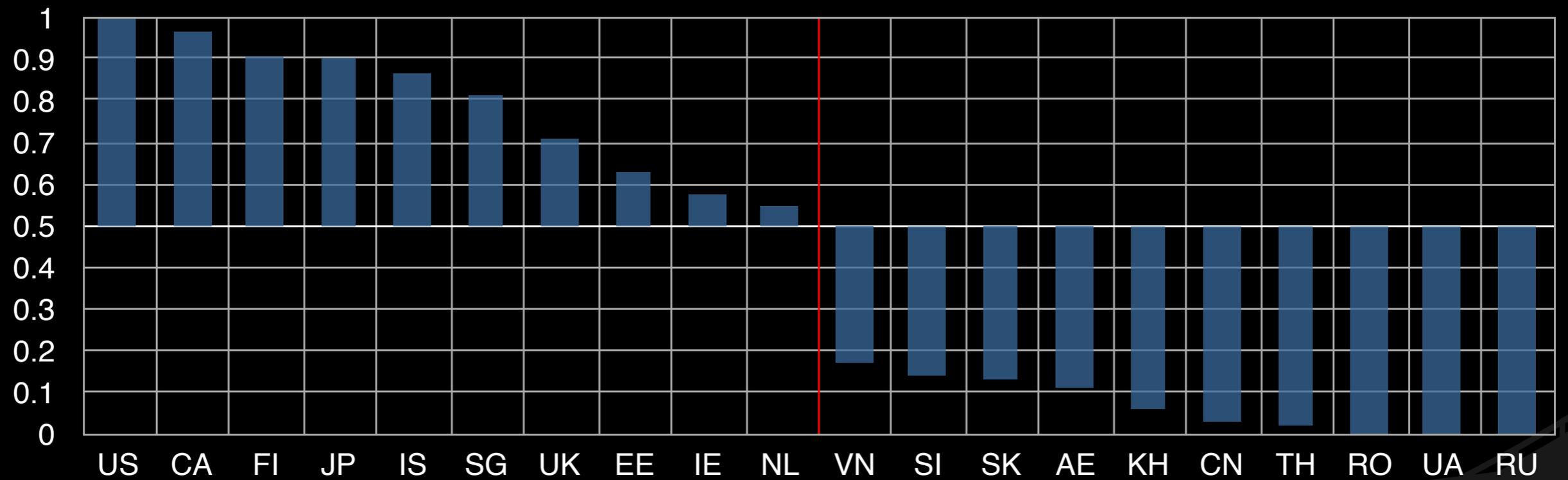
Market-dominant incumbents routinely advance the notion that “paid peering” or minimum peering requirements are commonplace. They do exist, but in vanishingly small numbers, and those numbers continue to dwindle rapidly relative to overall growth.

# Key Findings

**Strong preferences continue to exist for contractual country of governing law**, closely paralleling perceived law & order and the degree to which legislation and governmental policy protect carriers from liability for content.

The United States, Canada, and Japan remain favored and, post-Snowden, Iceland and Finland join the list of favored countries. By contrast Romania, the Ukraine, and Russia continue to be selected least often, and China and Thailand join them this year near the bottom of the list.

# Country of Governing Law



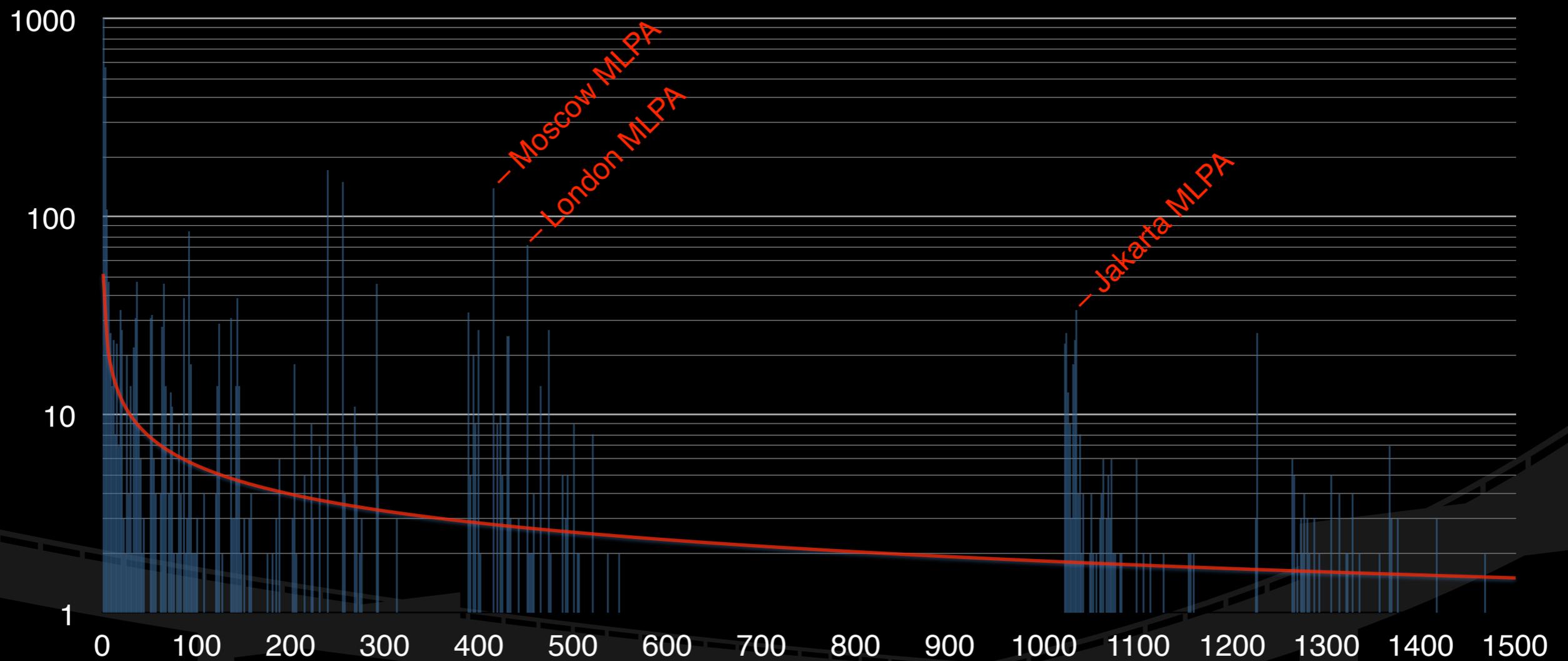
# Key Findings

**Nearly all peering is multilateral peering** implemented through route-servers and multilateral agreements.

Incumbents often attempt to deride multilateral peering as peripheral and inconsequential. In fact, it was already becoming the dominant practice in 2011, and accounts for the vast majority of AS adjacencies in 2016.

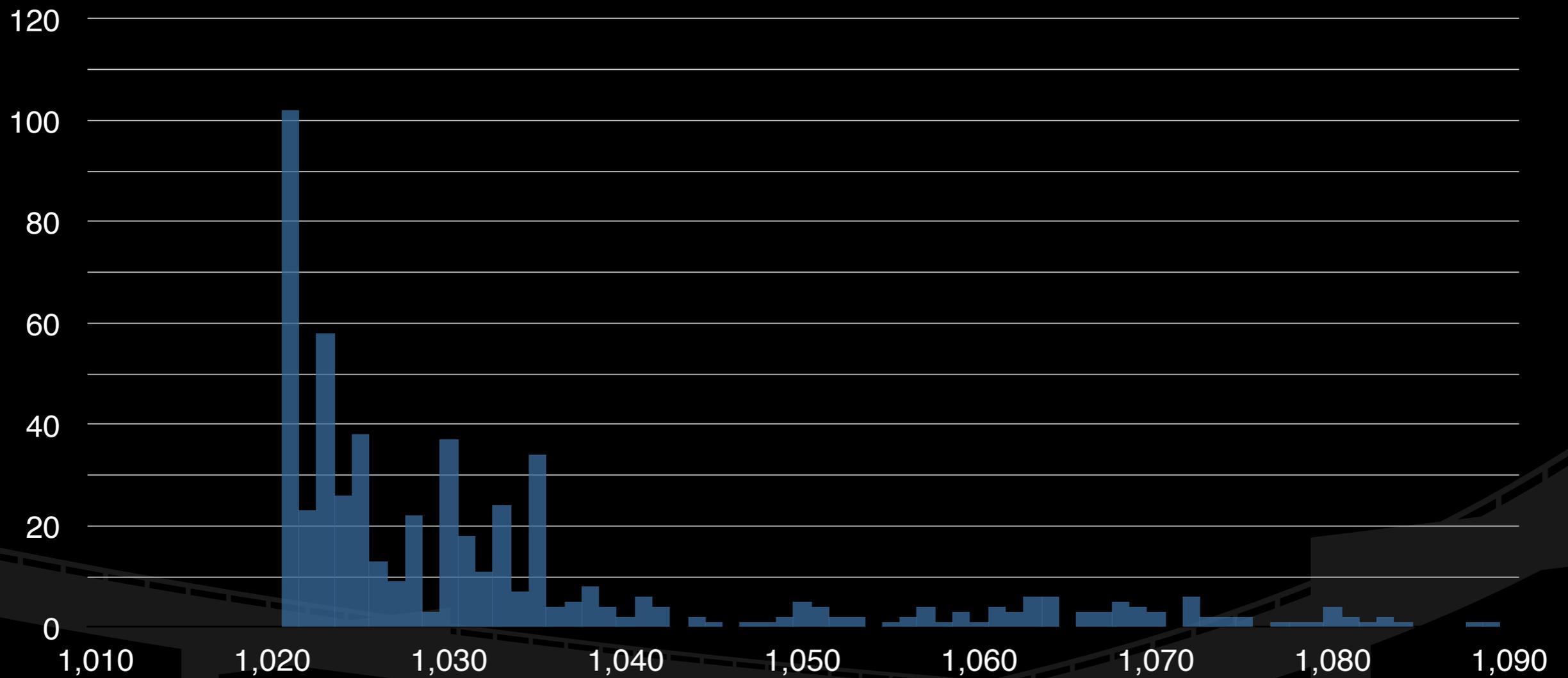
Multilateral peering commands less mind-share because it's fire-and-forget. An agreement is established once, and continues to accrue new participants over time.

# Interconnection Partners per Network

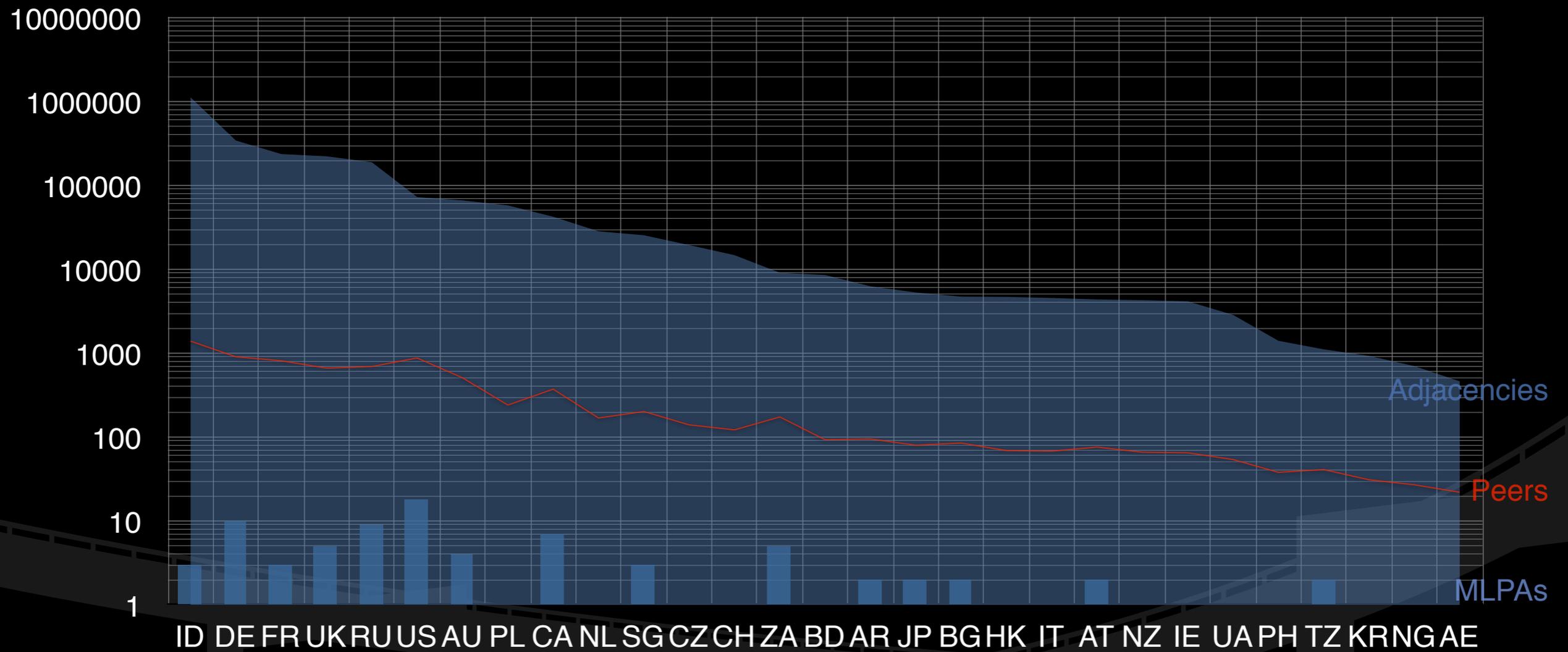


The 112 largest networks with between 1,500 and 4,500 interconnection partners are not displayed

# Jakarta Matrix Exchange MLPA



# Countries that Benefit from MLPAs

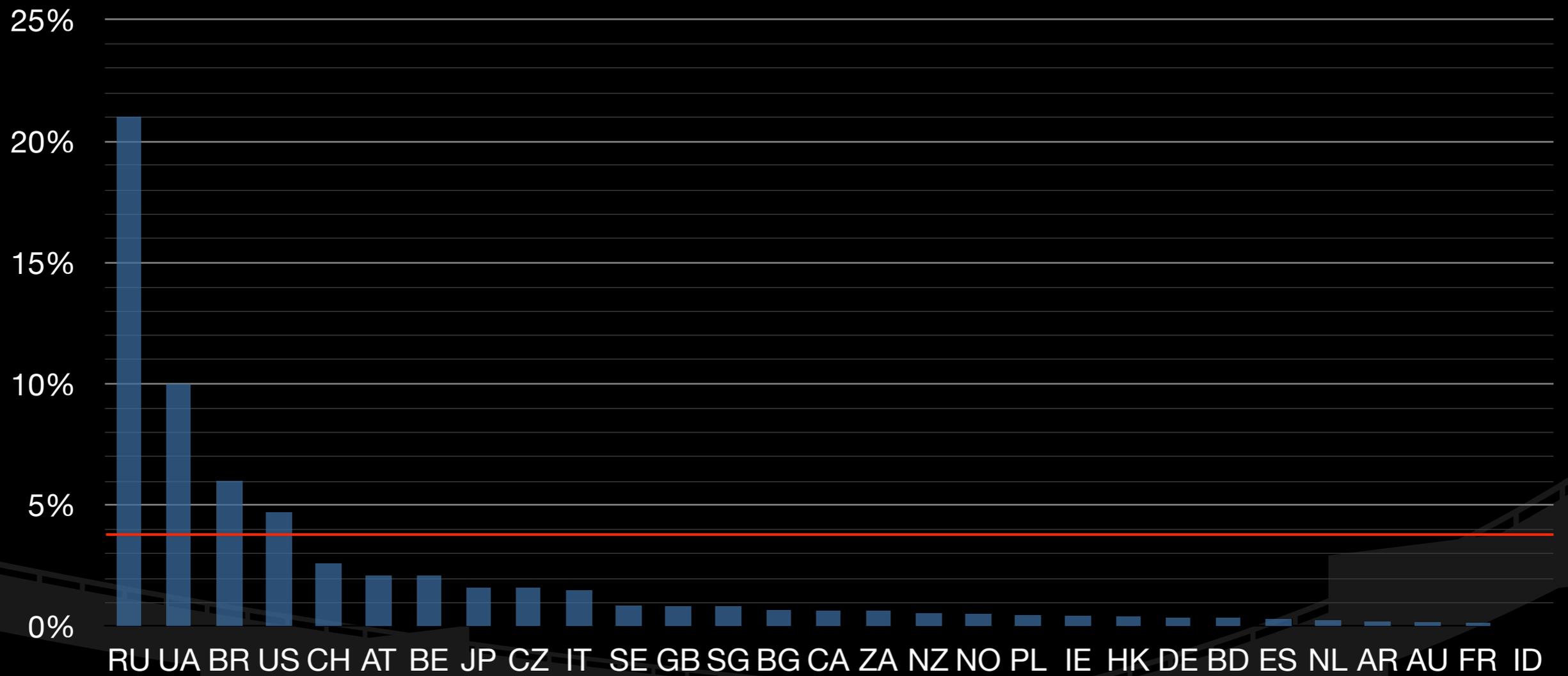


# Key Findings

**Only 74,886 (3.88%) were exchanging IPv6 traffic** while 1,854,411 (96.12%) were not. This is an unfortunate finding, as we're now twenty years into IPv6 deployment.

Of the thirty most-represented countries in our dataset, Russia had the highest average rate of IPv6 routing at 21%, followed by the Ukraine at 10%, Brazil at 6%, and the United States at 4.7%. Every other country in the top thirty fell below the global average of 3.88%

# IPv6 Routing



# IPv6 Routing

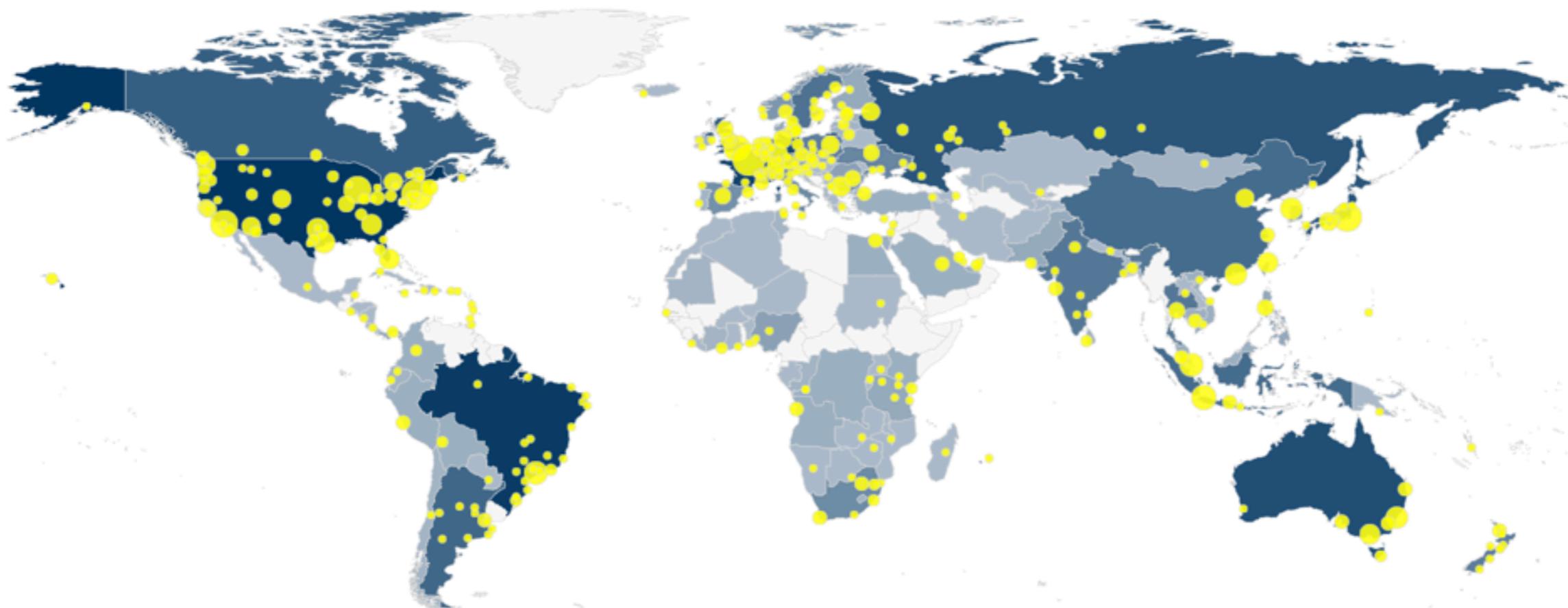
We observe a huge discrepancy between IPv6 support in large and small networks.

All of the dozen largest respondents were routing IPv6; they were, on average, advertising more than 100 IPv6 prefixes each and supported IPv6 with nearly 70% of their peers.

Of the smallest 50% of the respondents, 92.5% had no IPv6 peers or prefixes at all, they averaged 0.44 IPv6 prefixes, and supported IPv6 routing with 0.15% of their peers.

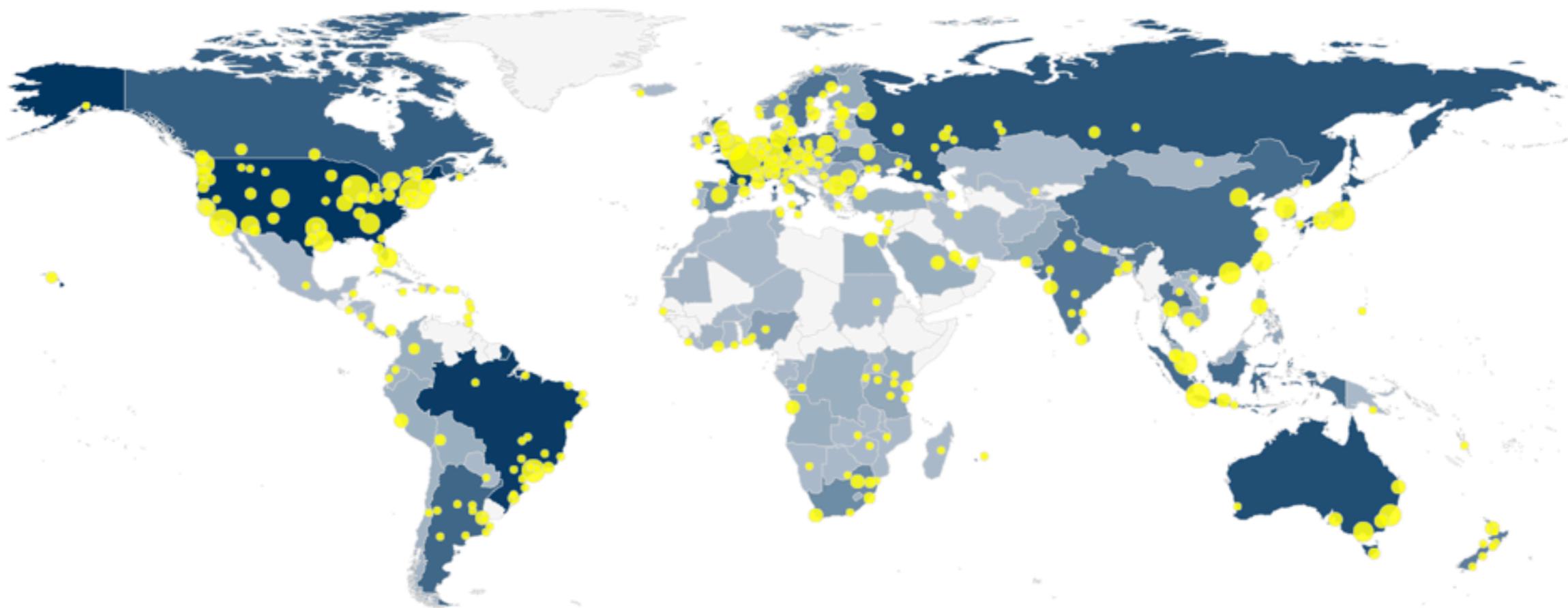


# Internet Exchange Directory



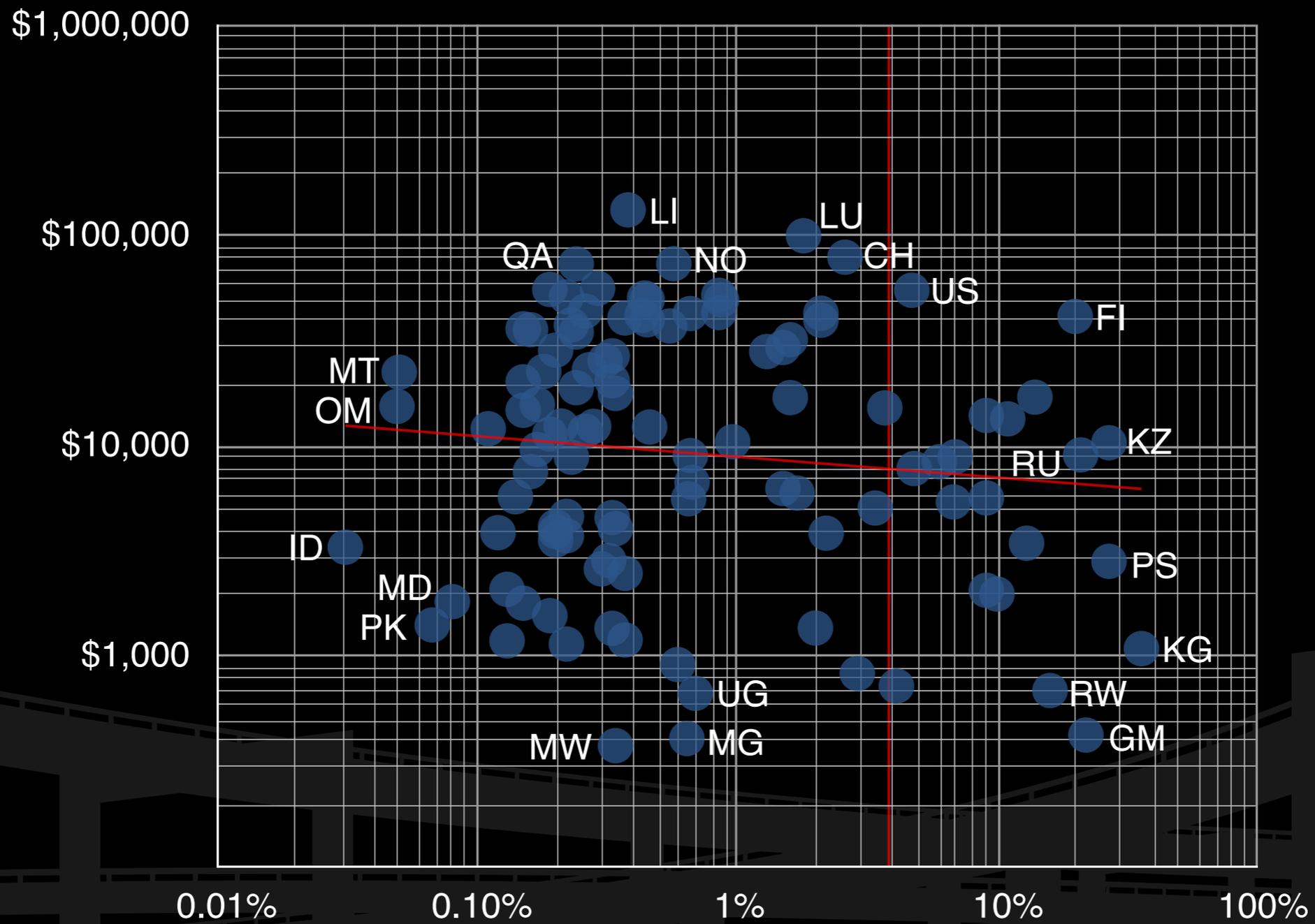
Region	Country	City	IXP Name	Participants	Traffic	IPv6 ▾	Prefixes	Established	URL
Europe	Russia	Moscow	MSK-IX Moscow	397	3.85T	17.5%	?	25 Nov 1995	<a href="#">↗</a>
North America	United States	Seattle	Seattle Internet Exchange	235	505G	4.75%	352190	20 Jun 1997	<a href="#">↗</a>
Europe	Netherlands	Amsterdam	Amsterdam Internet Exchange	783	7.69T	2.1%	1042608	29 Dec 1997	<a href="#">↗</a>

## Internet Exchange Directory

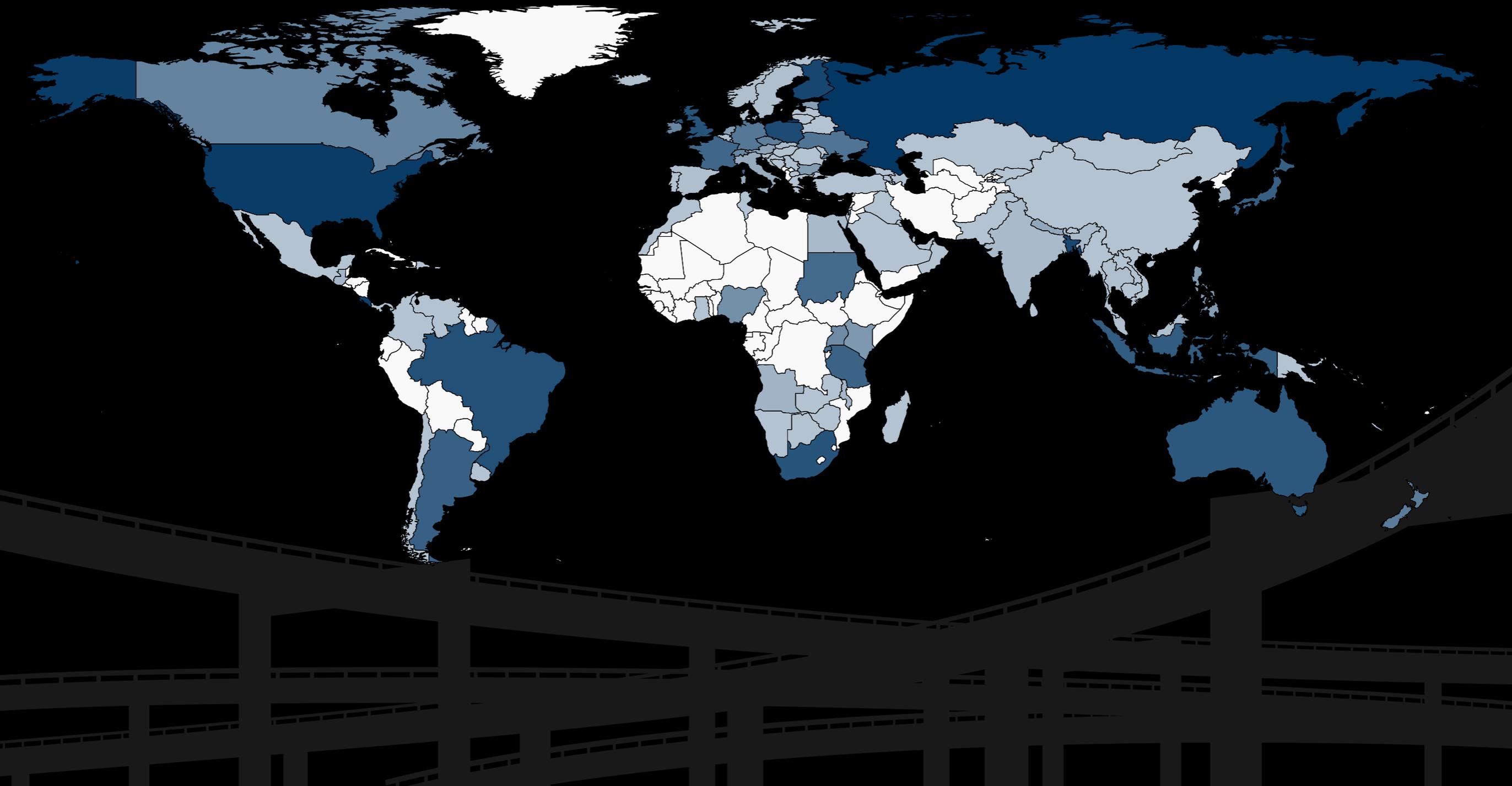


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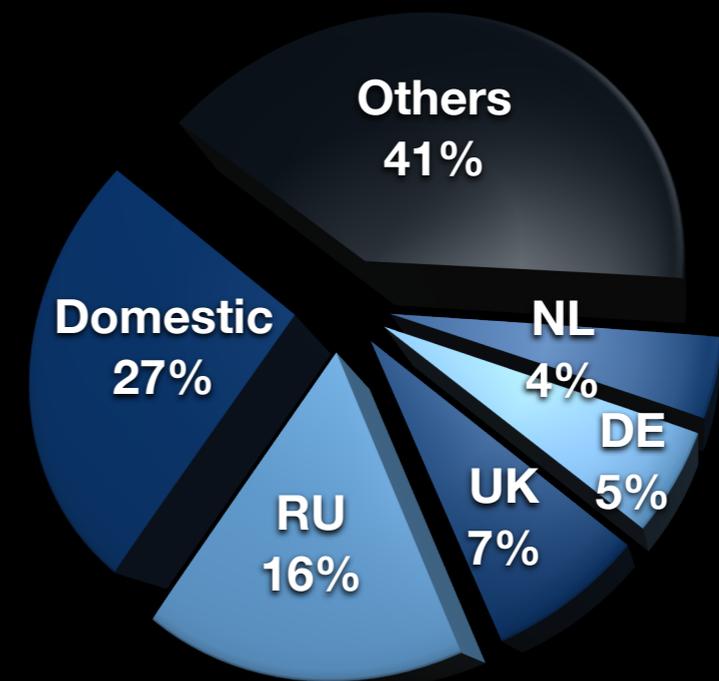
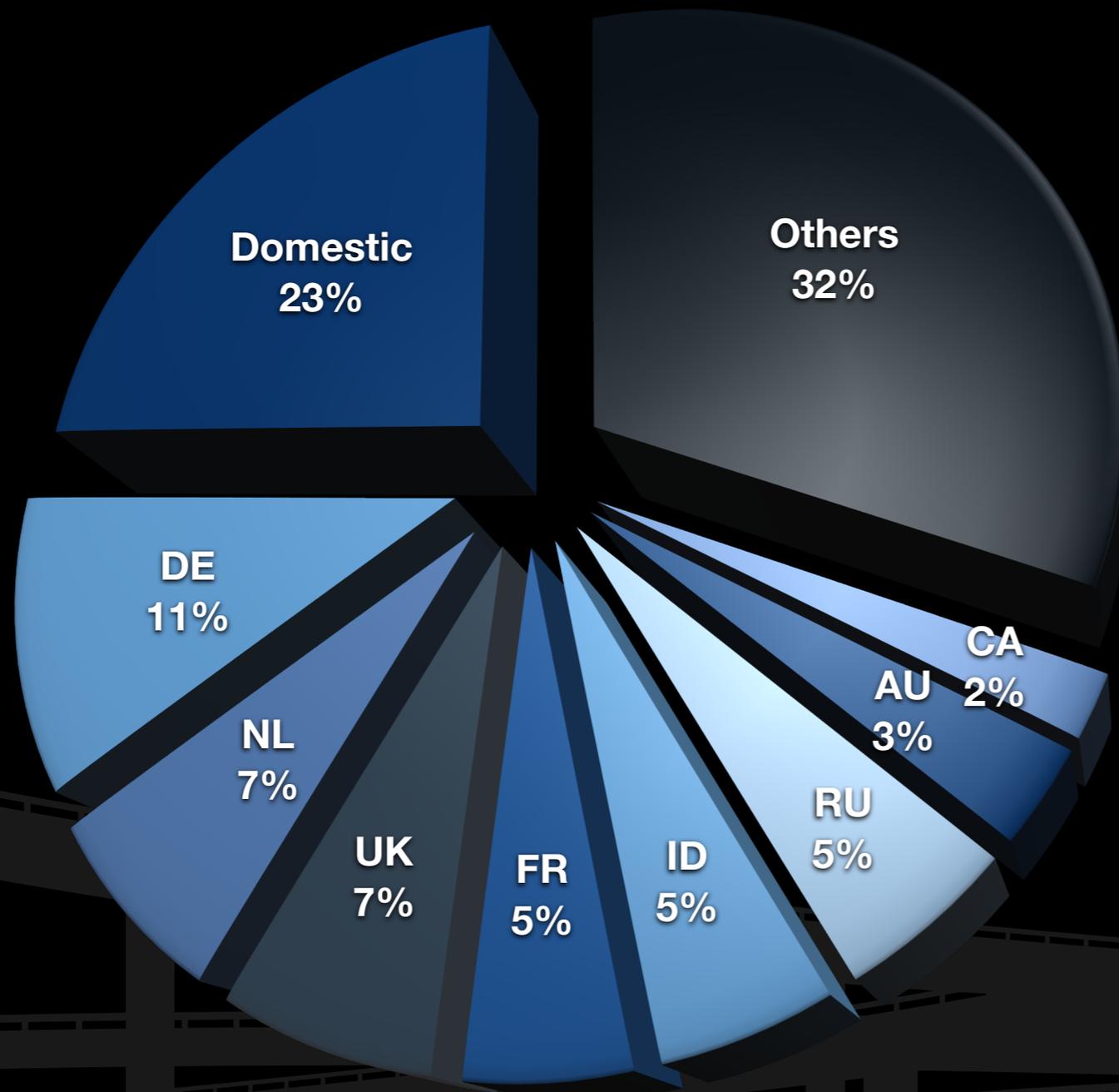
# IPv6 Routing vs. GDP PPP: No Correlation



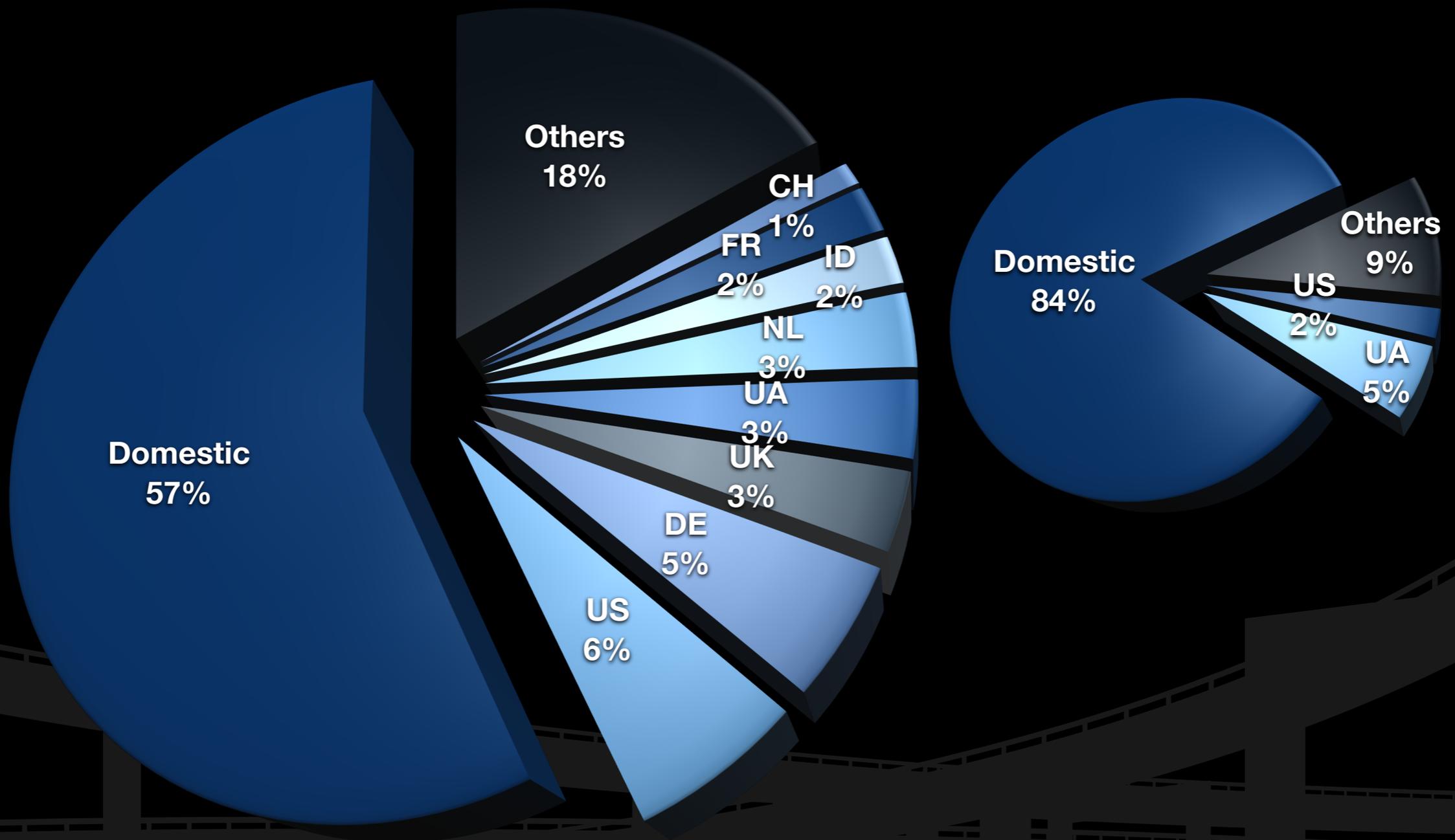
# Domestic vs. International



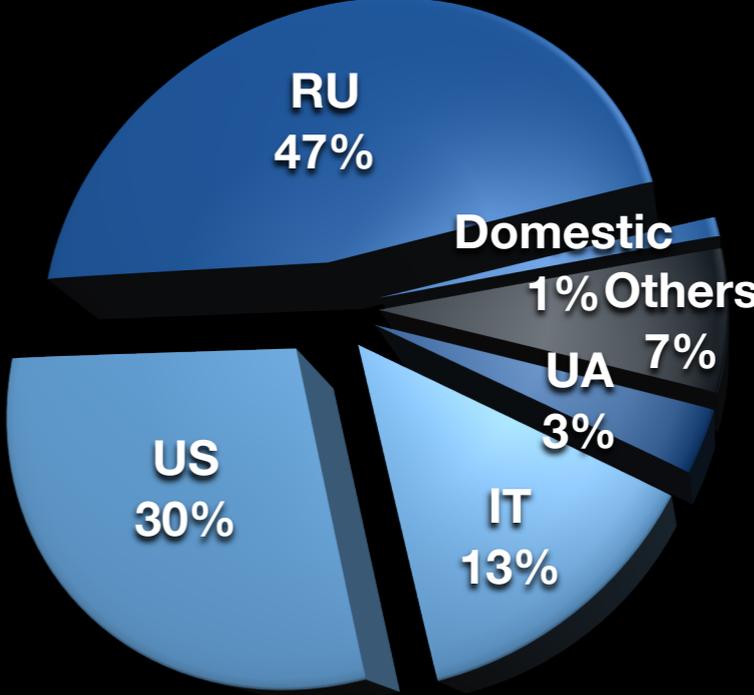
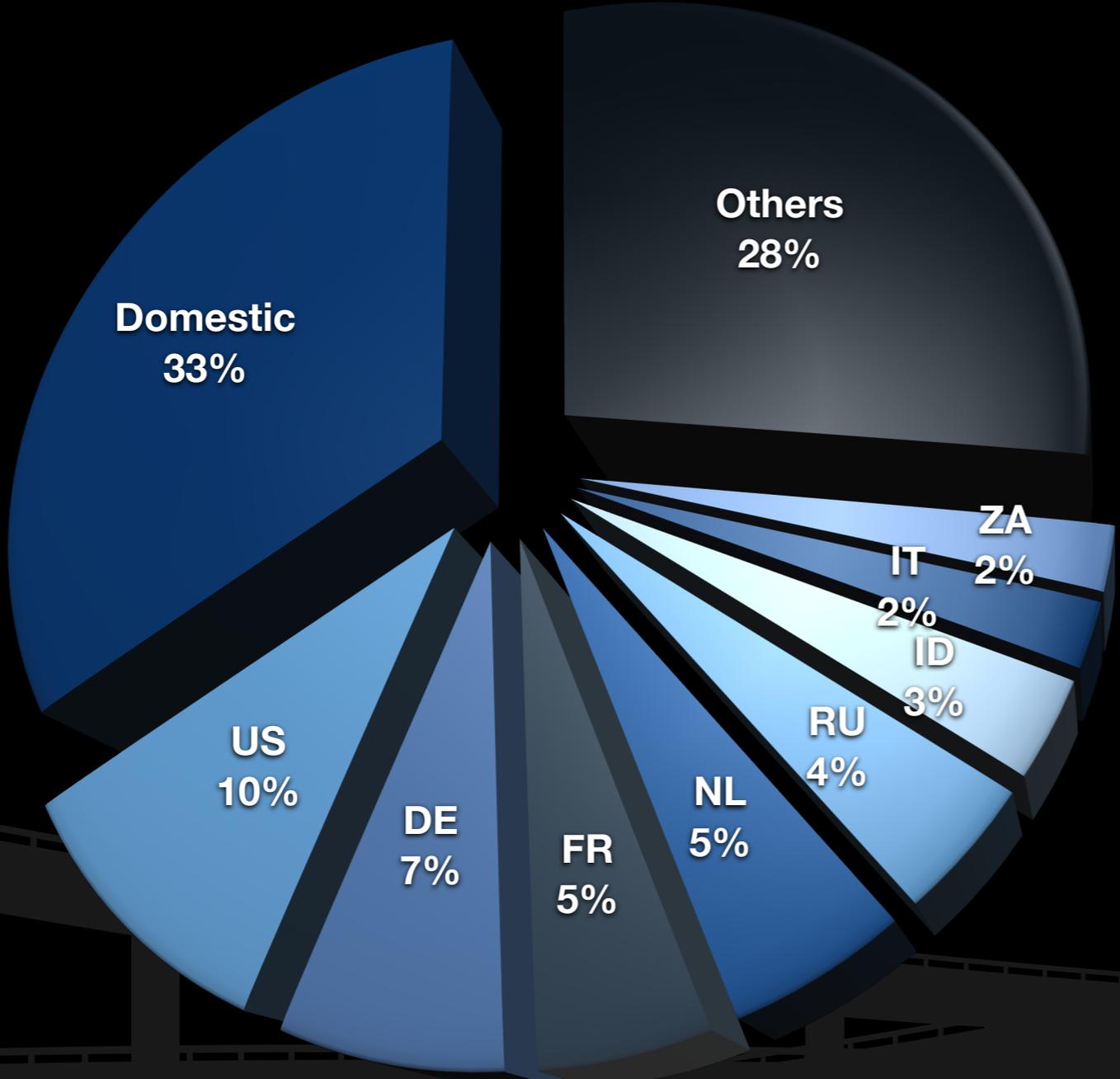
# American Interconnection Partners



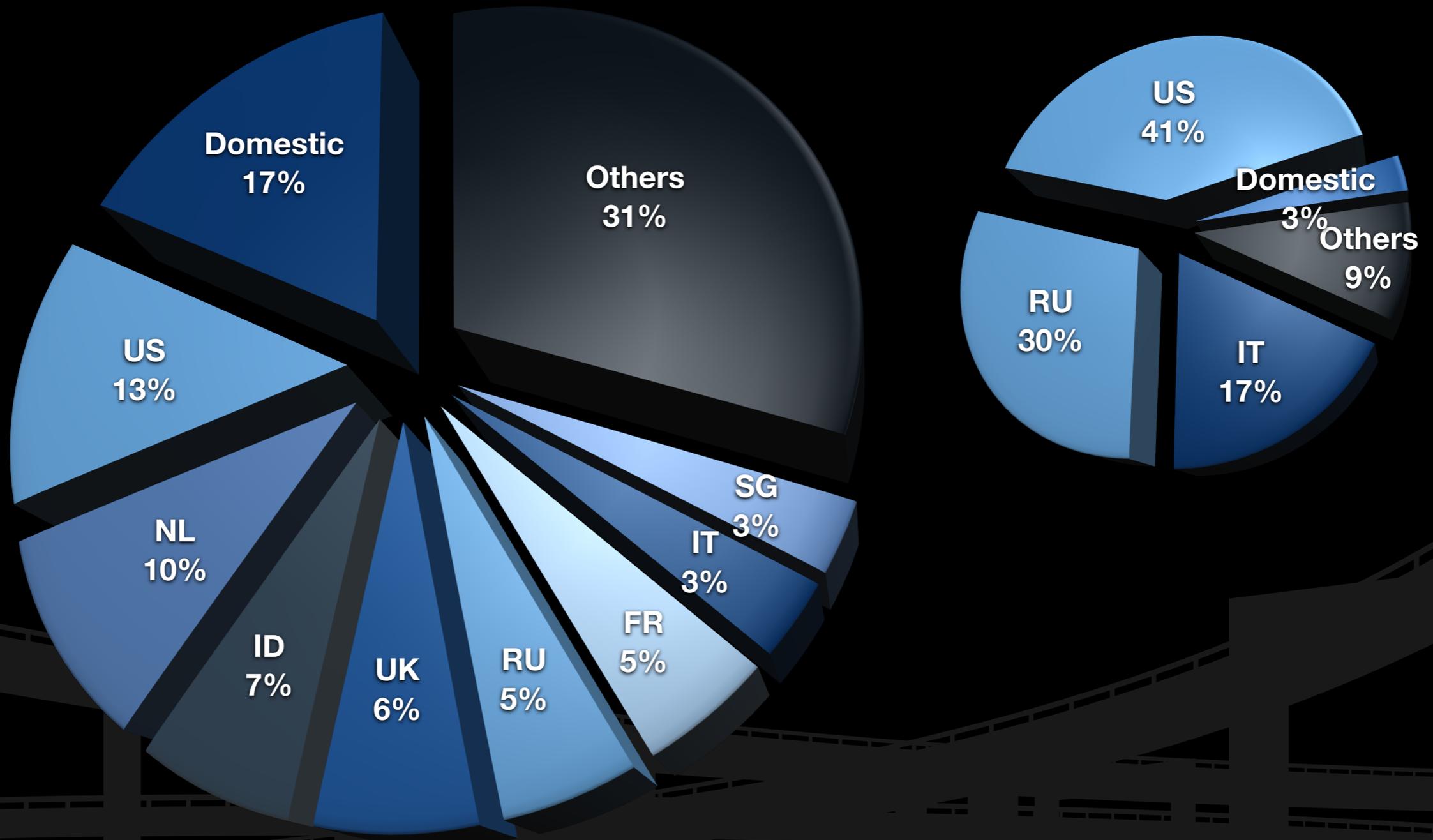
# Russian Interconnection Partners



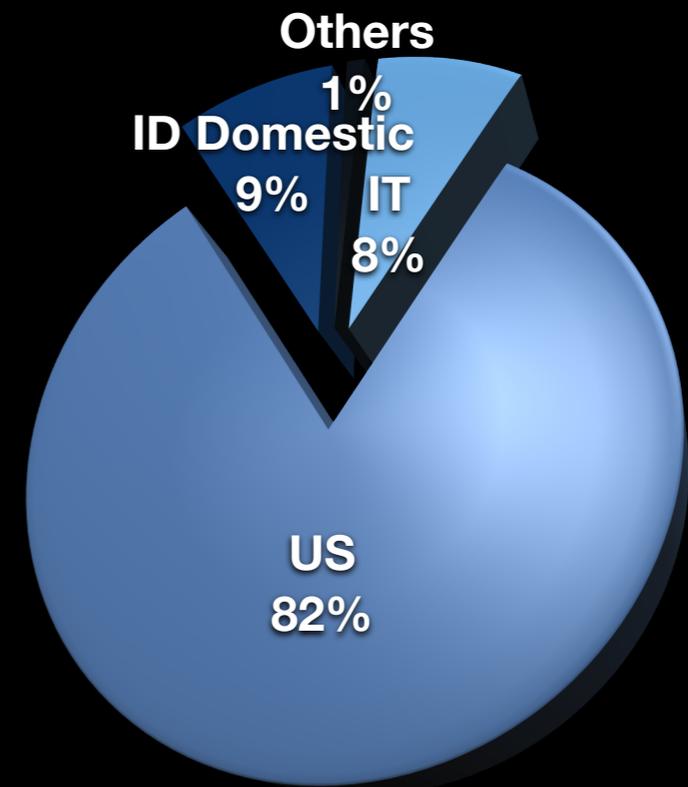
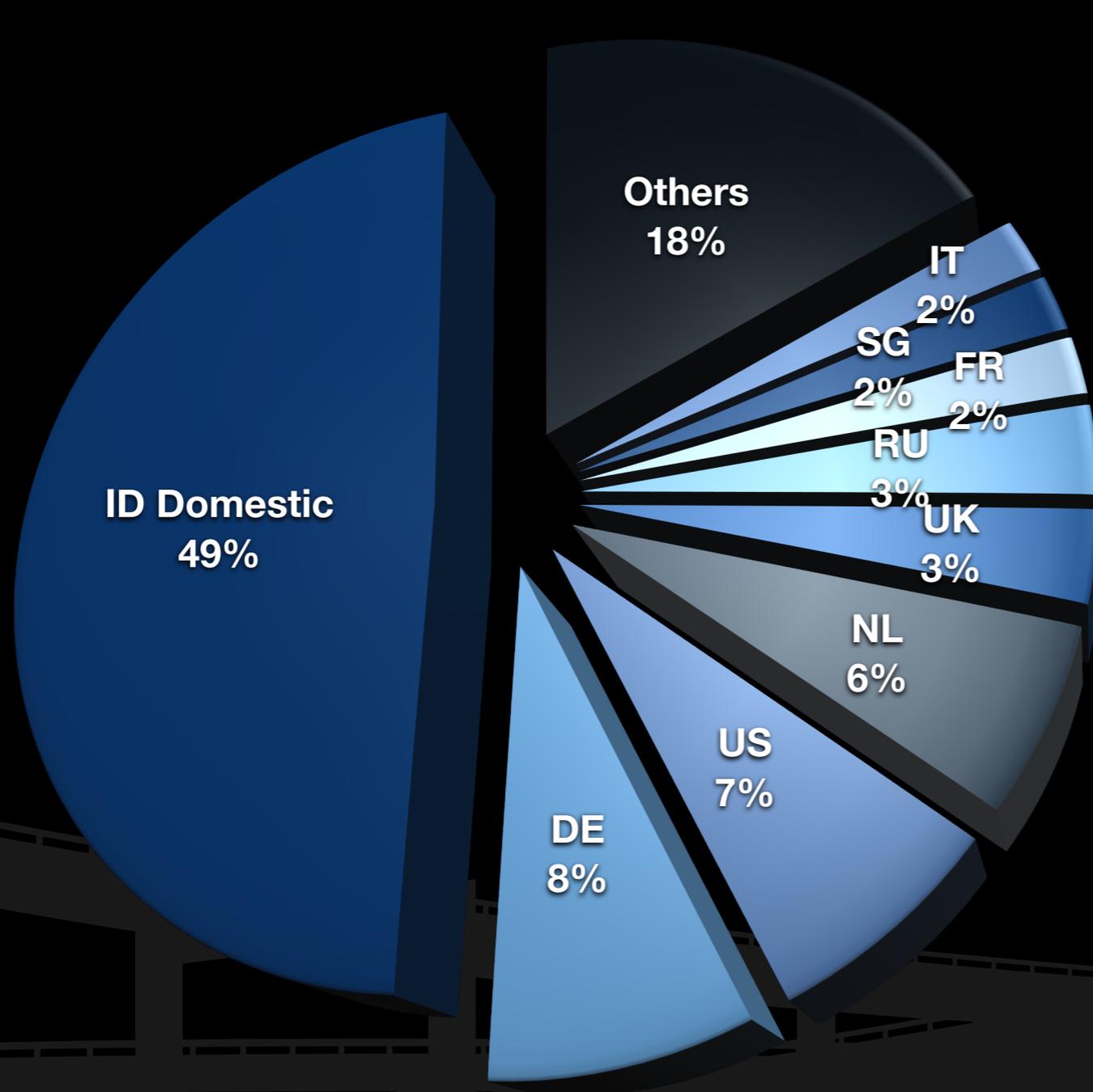
# British Interconnection Partners



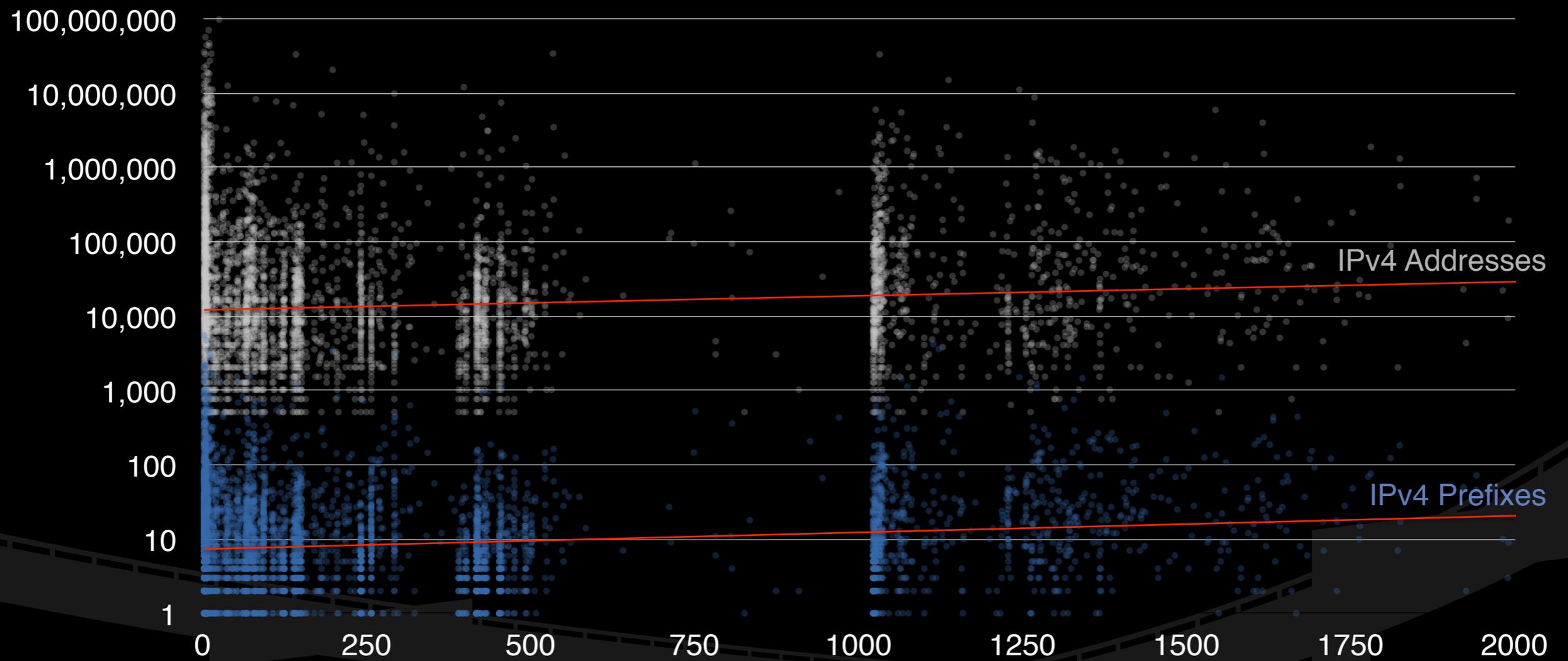
# German Interconnection Partners



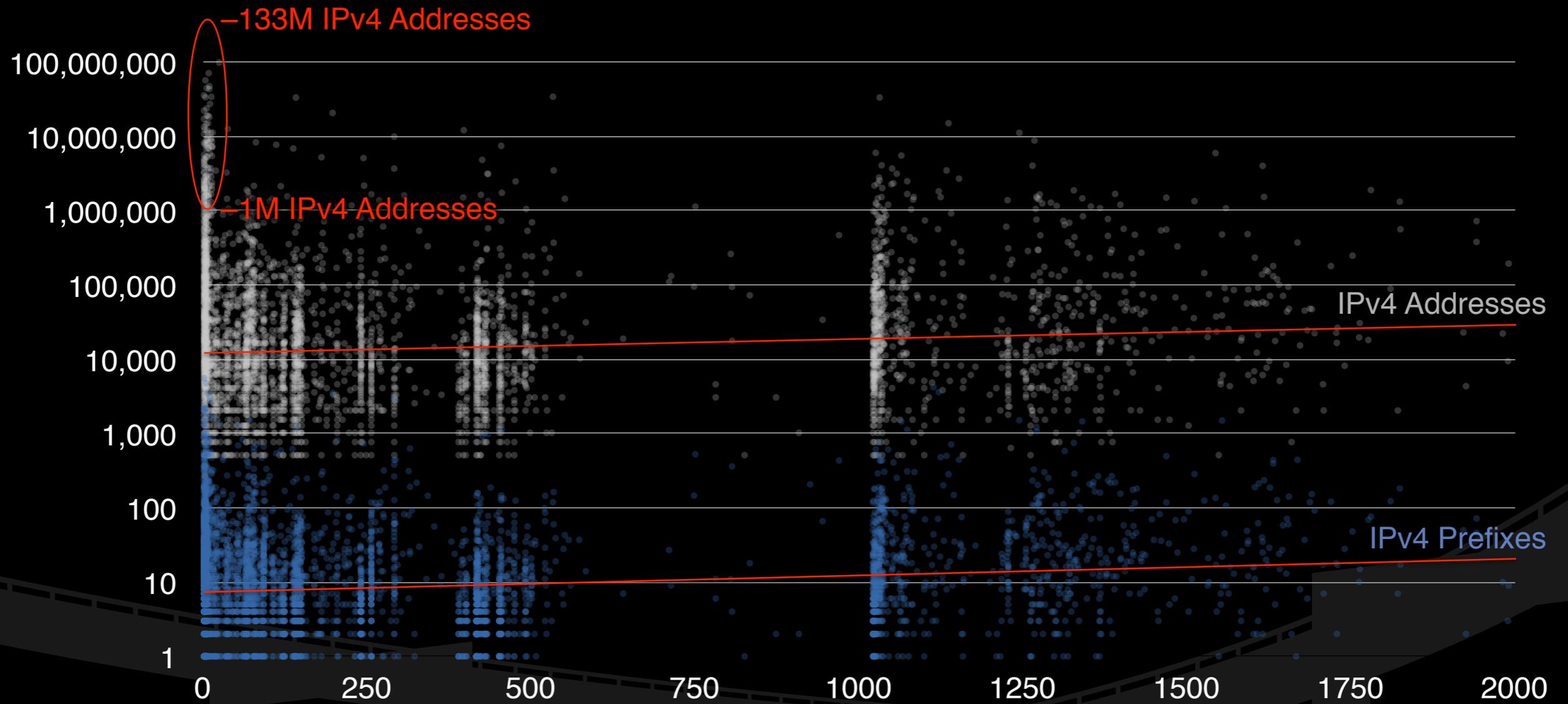
# Indonesian Interconnection Partners



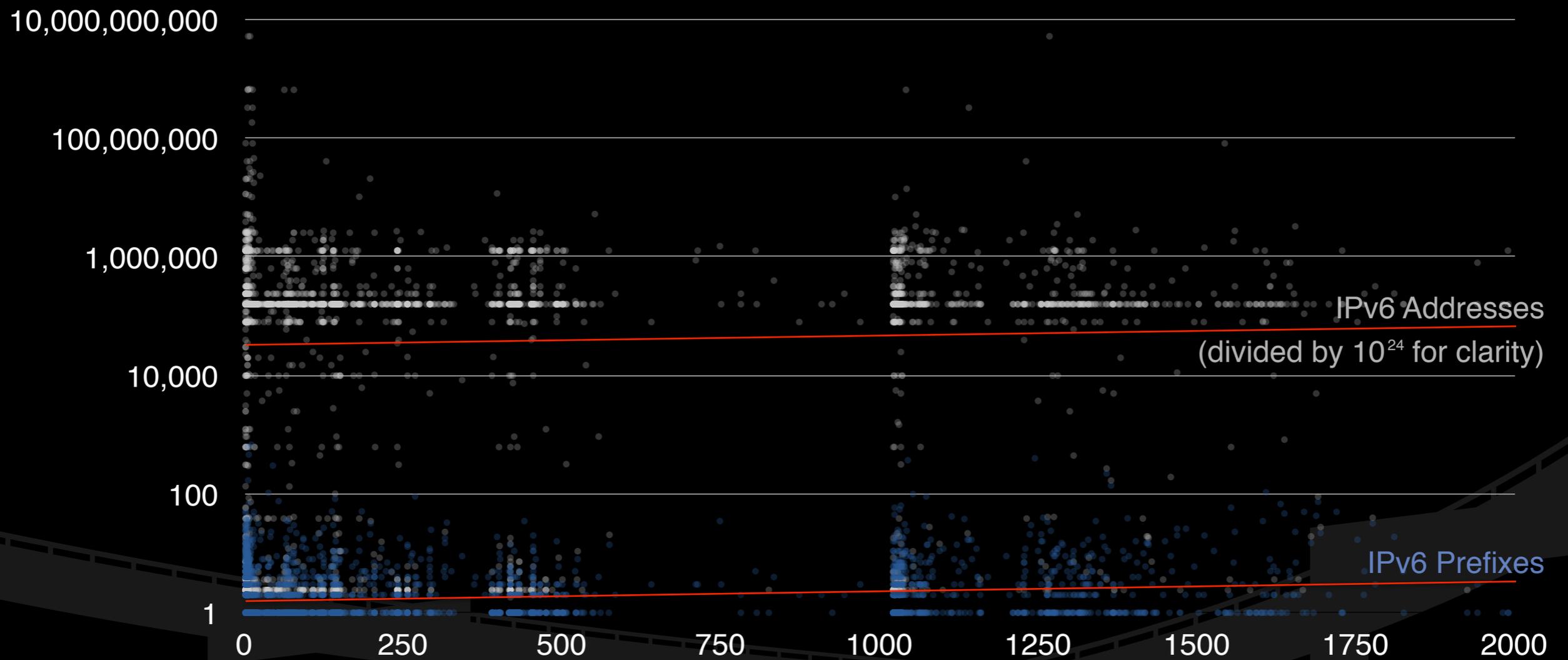
# IPv4 Size Relative to Number of Interconnections



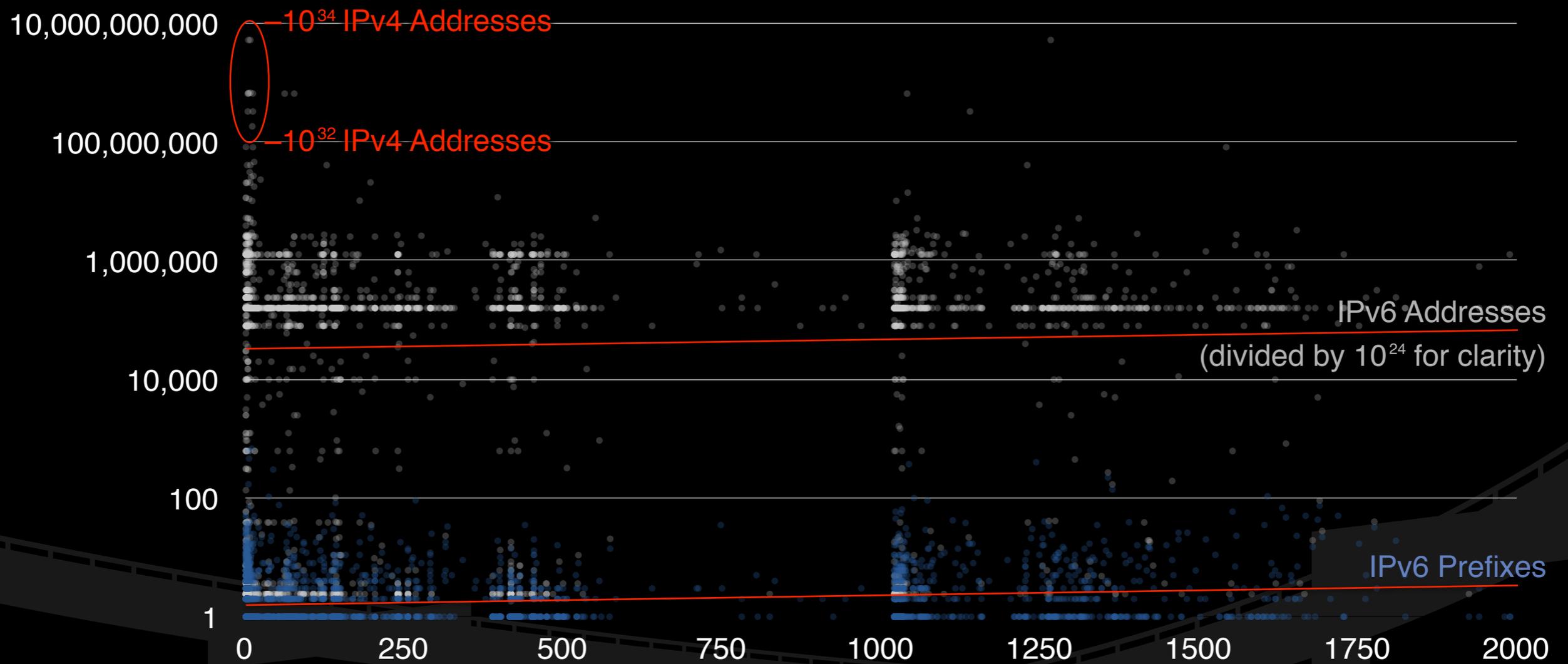
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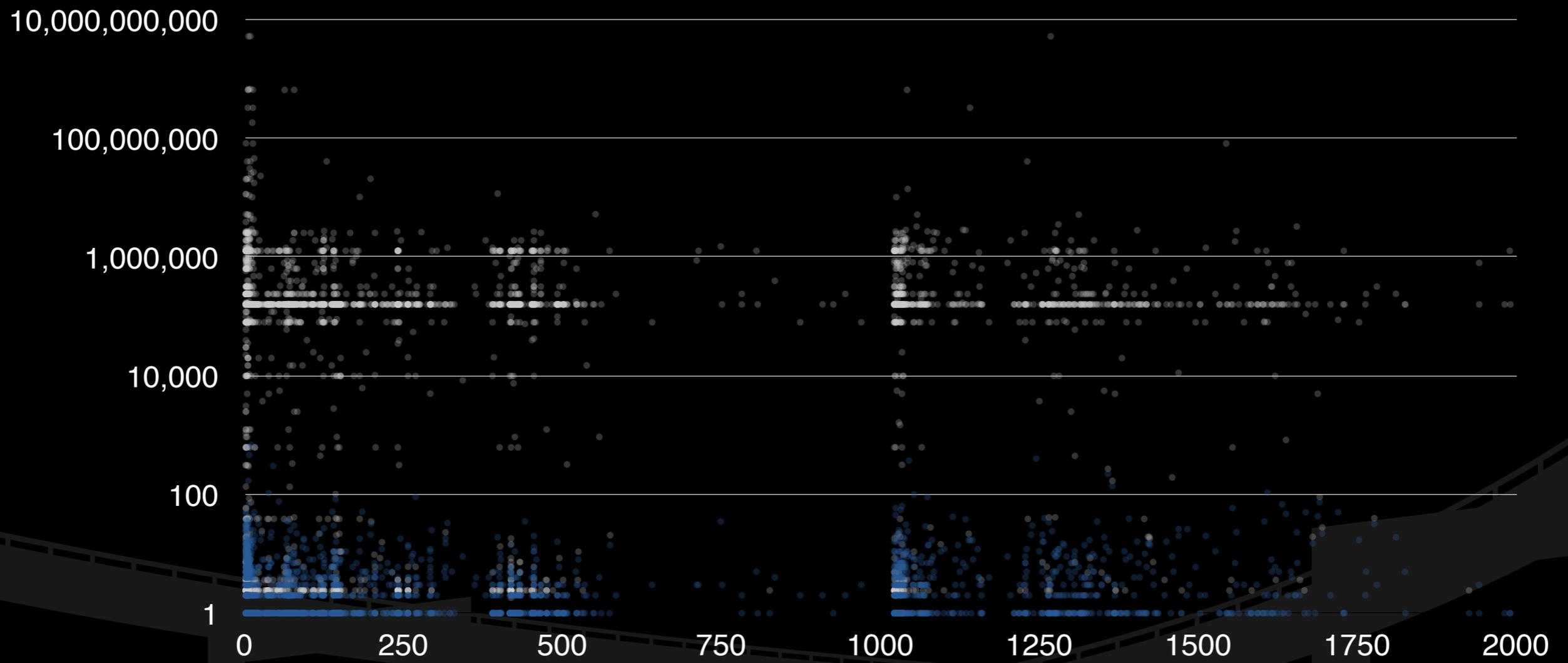
# IPv6 Size Relative to Number of Interconnections



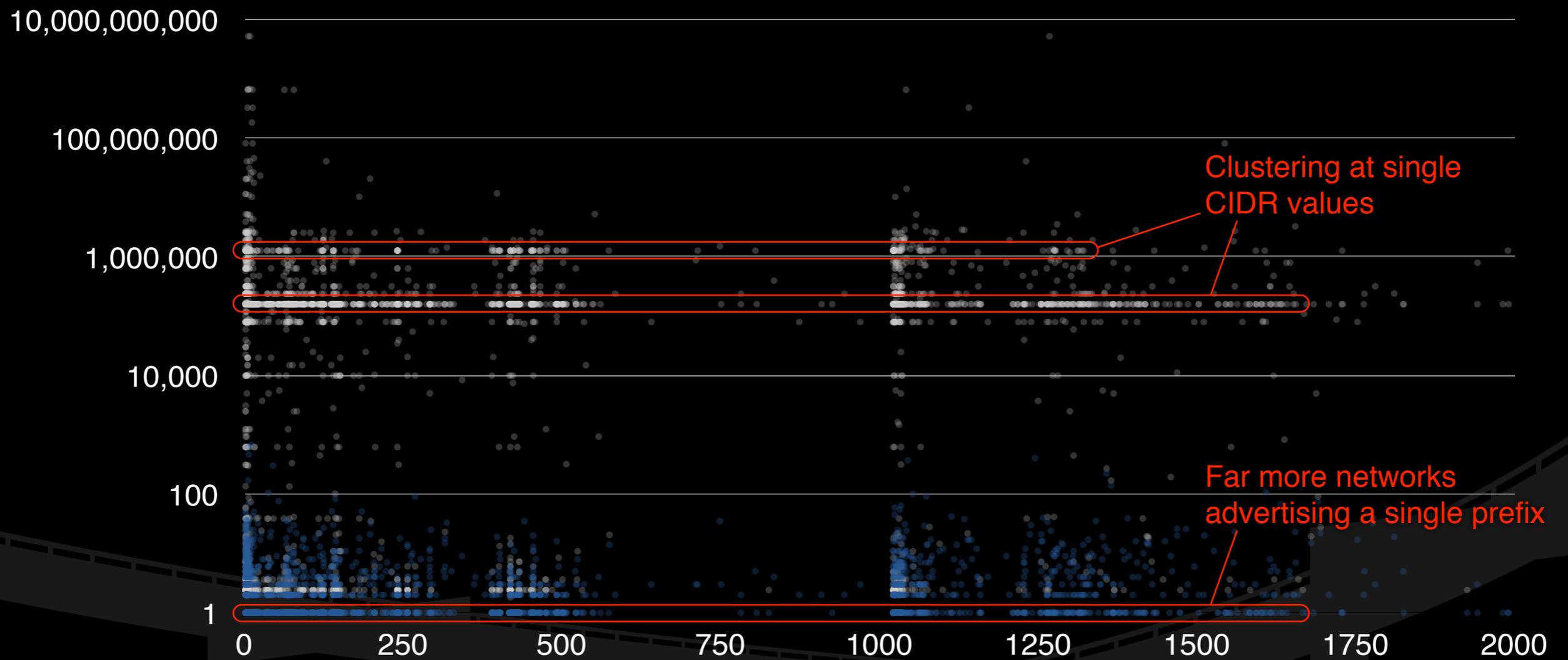
# IPv6 Size Relative to Number of Interconnections



# IPv6 Size Relative to Number of Interconnections



# IPv6 Size Relative to Number of Interconnections



# Thanks, and Questions?

Copies of this presentation are available in PDF format.

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