IP Addressing: Past, Present and Future

MyNOG 11
Kuala Lumpur, Malaysia

5 June 2024

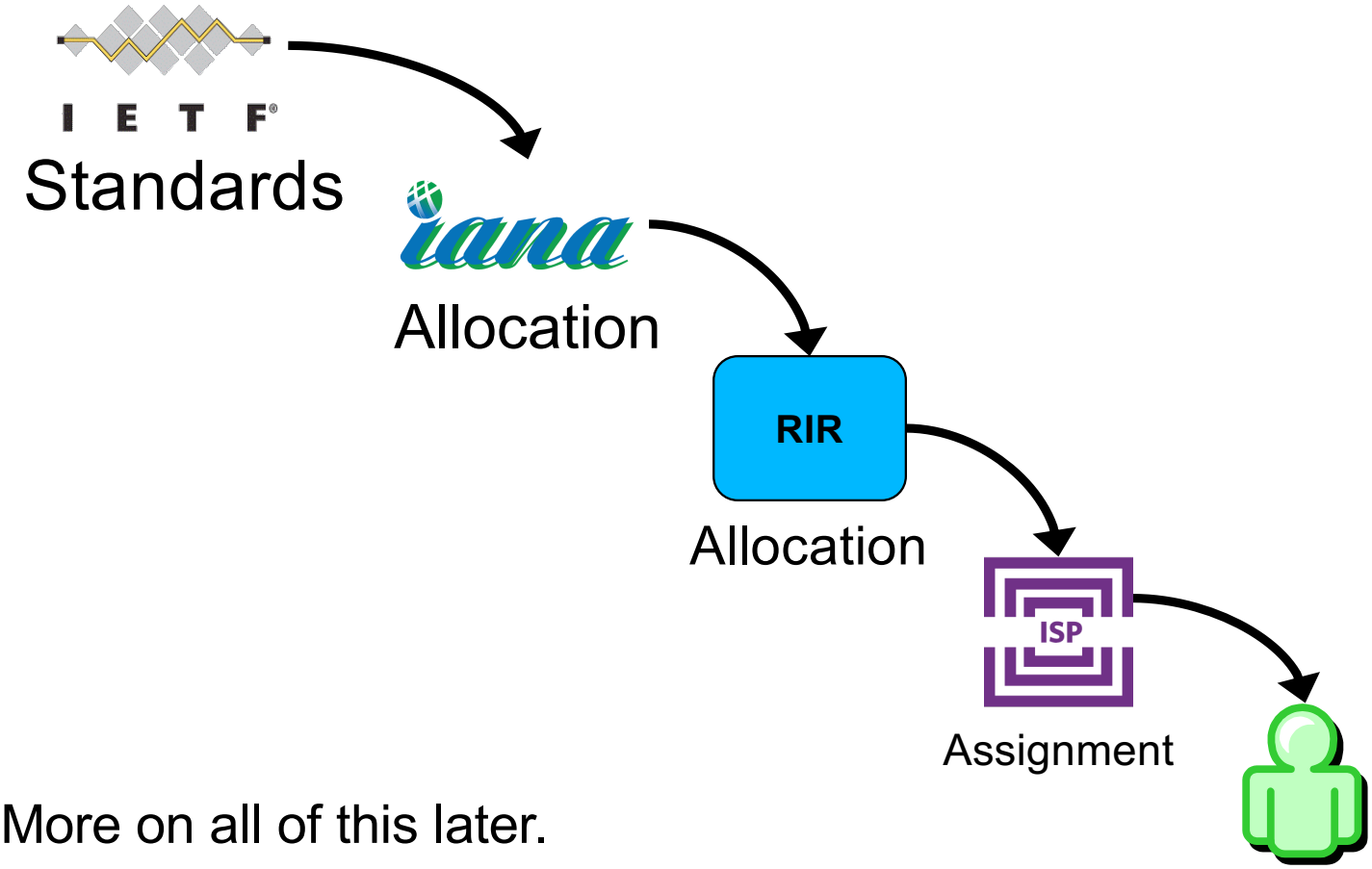
Coming up…

- The Past: Origins
- The Present: Transition
- The Future: Good news!
- About APNIC

The Past: Origins

APNIC

Where do IP Addresses come from?



More on all of this later.

Where do IP Addresses come from?

IETF

Standards

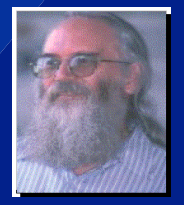
iana

Allocation

Early days: 1981 – 1992

1981:

*"The assignment of numbers is also handled by Jon. If you are developing a protocol or application that will require the use of a link, socket, port, protocol, or network number **please contact Jon to receive a number assignment**." (RFC 790)*



Boom times: 1992 – 2001

1992:

"It has become clear that … these problems are likely to become critical within the next one to three years." (RFC1366, Gerich)
"…it is [now] desirable to consider delegating the registration function to an organization in each of those geographic areas." (RFC 1338)

Boom times: 1992 – 2001

1993:

RIR requirements defined (RFC 1466, Gerich)

Maturity: 2000s…

1999:

Internet Corporation for Assigned Names and Numbers (ICANN)

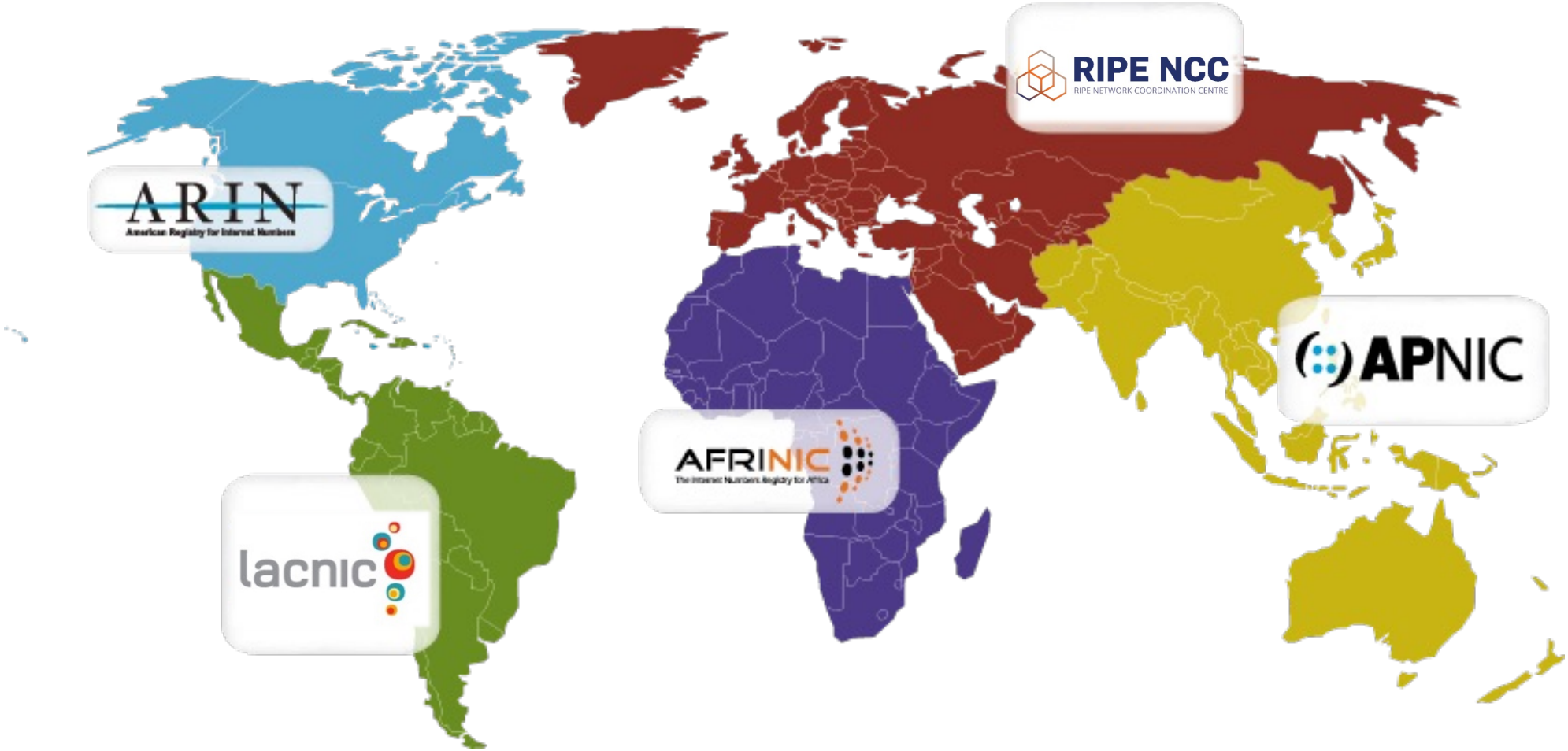
2004:

Number Resource Organisation (NRO)

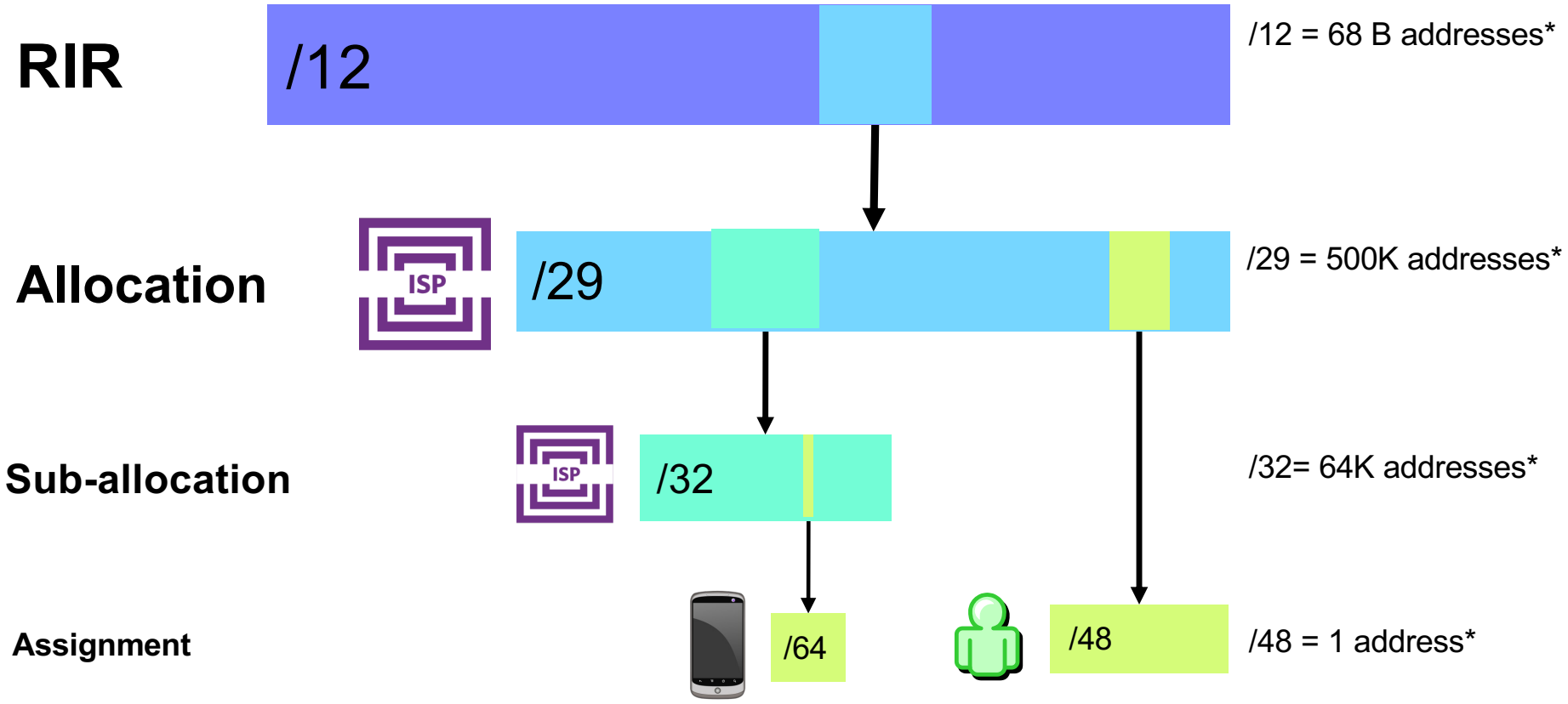
What do RIRs do?

- Internet number resource management
  - IP addresses: IPv4 and IPv6; and Autonomous System Numbers
  - Resource allocation, registration (“whois”), transfer
  - Resource Resource certification (RPKI, ROA publication)
- Policy development process
  - Coordination and support of PDP
  - Open Policy Meetings
  - Global policy process (via ASO and ICANN)
- Public representation and advocacy
  - Governmental and inter-Governmental spaces
  - Defense of the Internet and its multistakeholder governance

Regional Internet Registries today



Hierarchical Address Delegation (IPv6)



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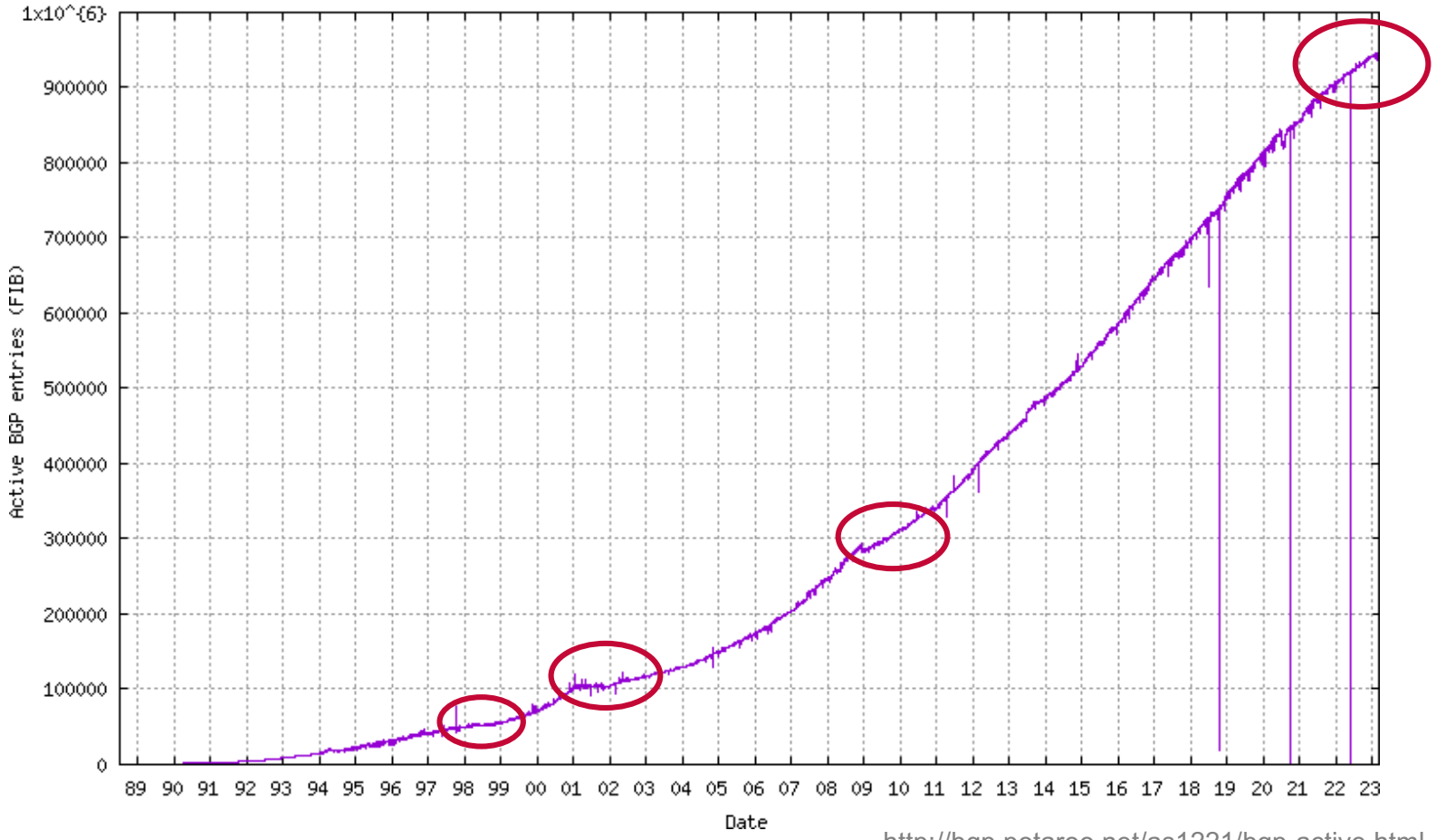
Policy Development Process

Join on https://orbit.apnic.net

Policy in use : IPv4 Routing Table – Prefixes

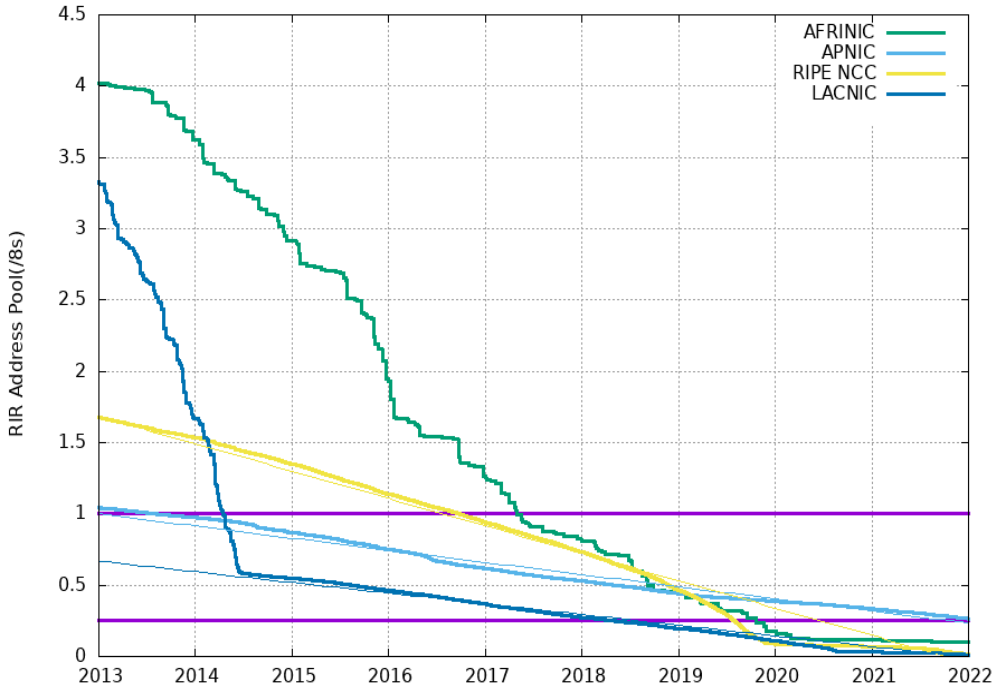


http://bgp.potaroo.net/as1221/bgp-active.html

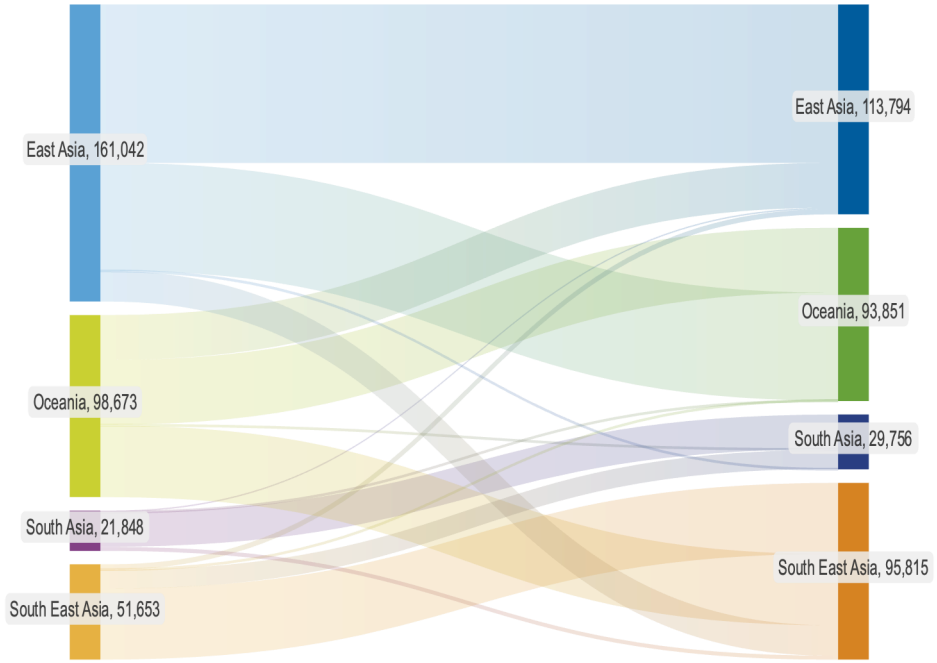
The Present: Transition

APNIC

IPv4 exhaustion…



http://www.potaroo.net/tools/ipv4



APNIC internal

IPv4 exhaustion…

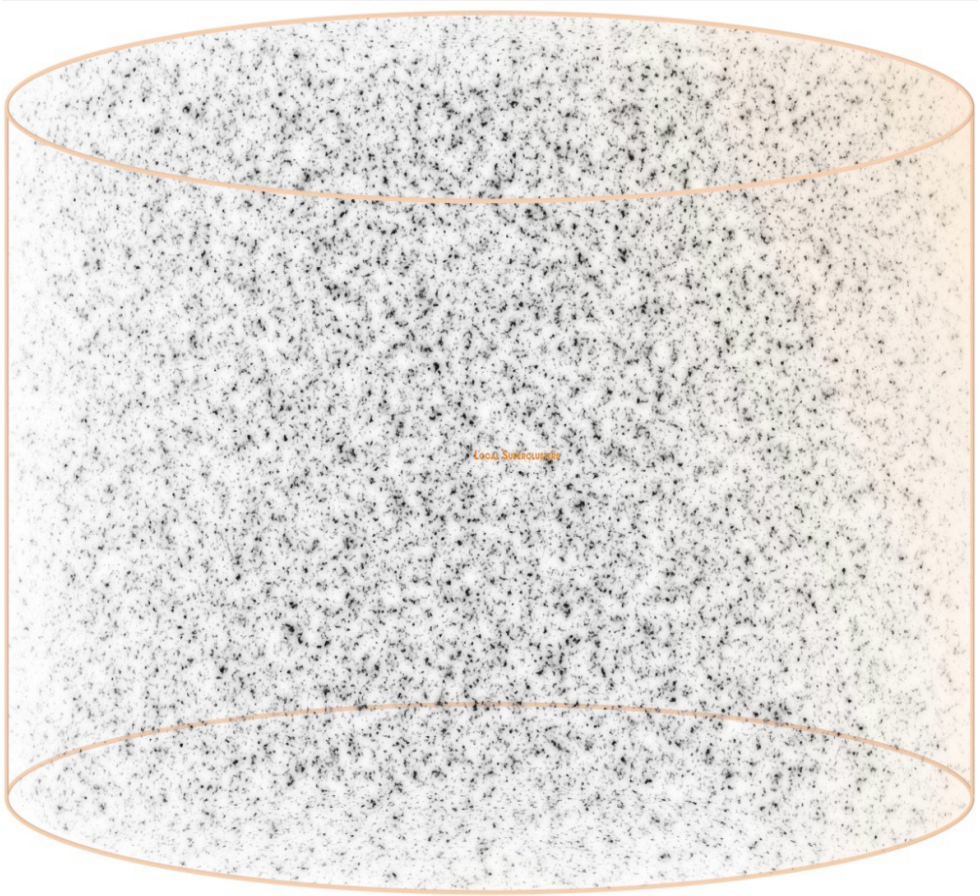
- IANA pool expired in 2011
  - RIR regional supplies followed (2012 to 2017)
  - Only APNIC has remaining supply (after reclamation in 2023)
- Delaying the inevitable…
  - Address sharing, Network Address Translation (NAT), CGNAT
  - RIR-registered transfers (sales or leases)
- Trading in the remains…
  - Purchase and leasing
  - Chaotic white/grey/black markets
  - **Price: 10 to 1,000x the price of registration**

The need for IPv6…

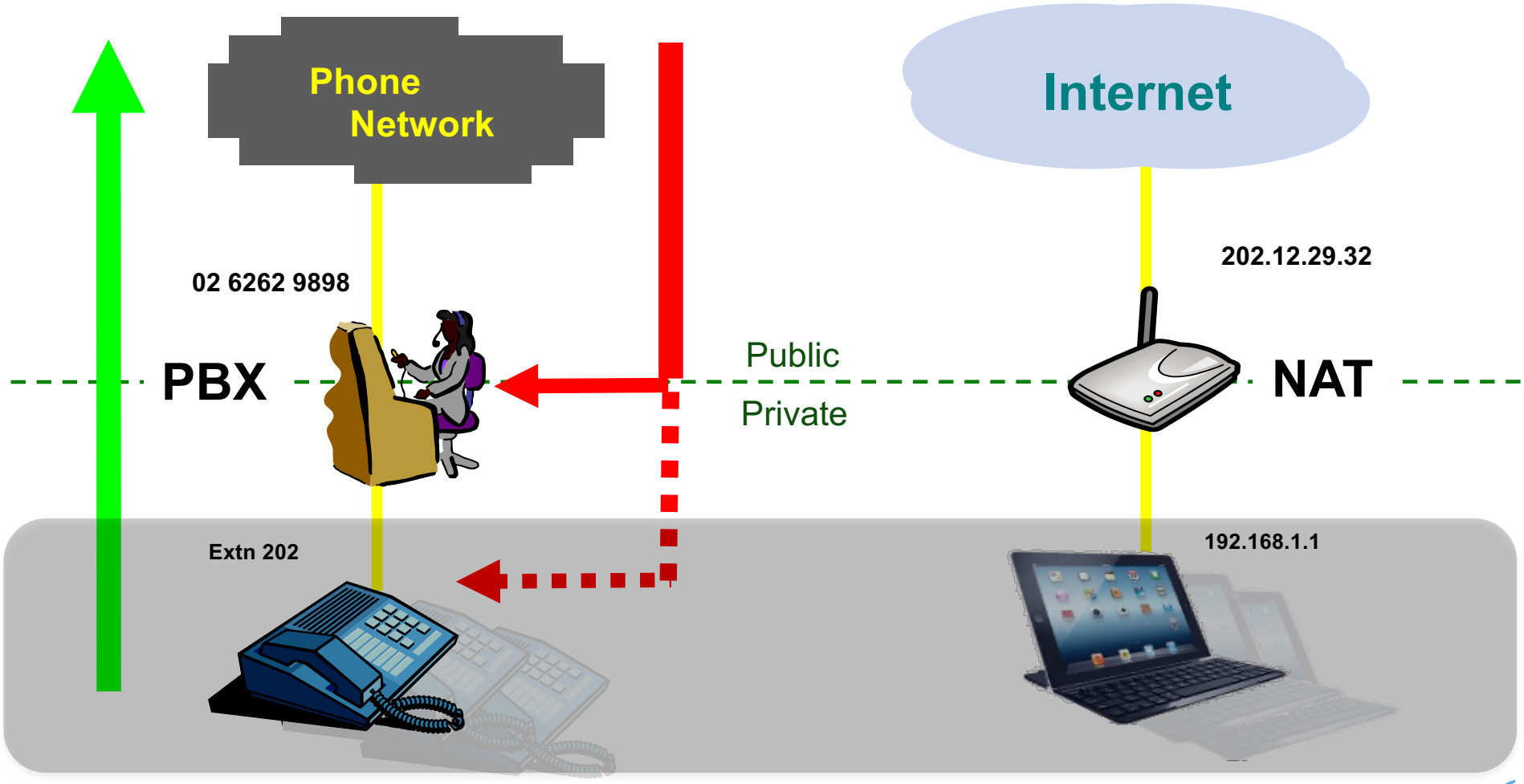
- One reason: more IP addresses
  - Other benefits are minor
- The Internet will keep growing
  - Broadband, wifi, 4G, 5G…
  - Internet of Things
- IPv6 is the only viable option
  - Enable sustainable growth of the Internet
  - Without IPv6 the future isn't great
- But will it work?
  - Yes, eventually…

IPv6 address space

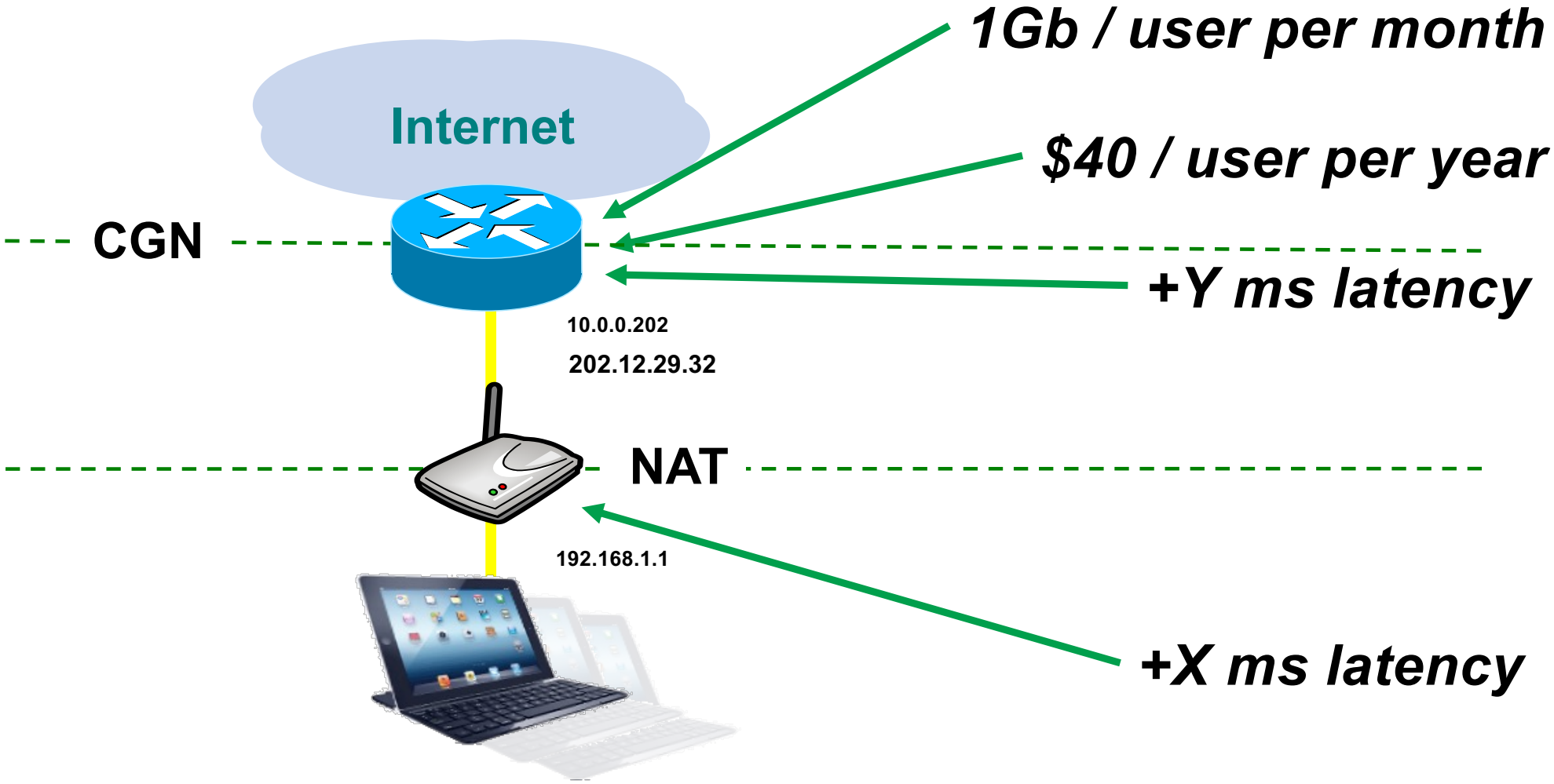
- IPv4: 32-bit address
  - 2^{32} = 4,294,967,296
  - The number of stars in the observable universe
- IPv6: 128-bit address
  - 2^{128} = 340,282,366,920,938,463,463,374,607,431,768,211,456
  - **Each of those stars contains an entire IPv4 Internet**



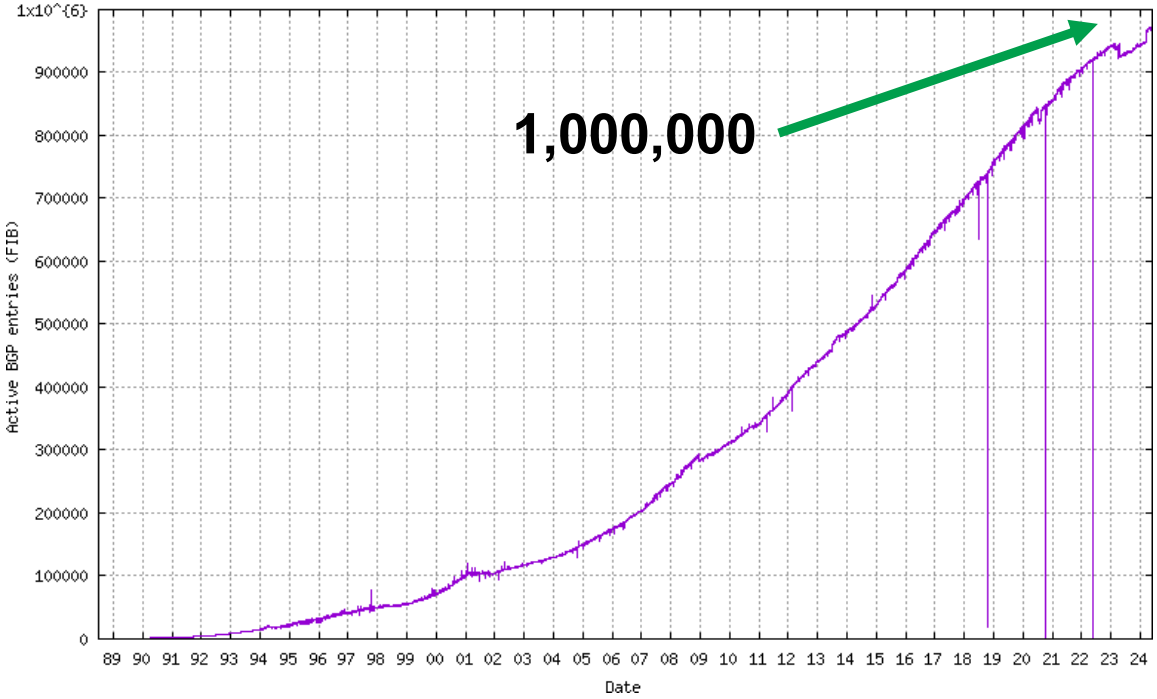
Address sharing and NAT



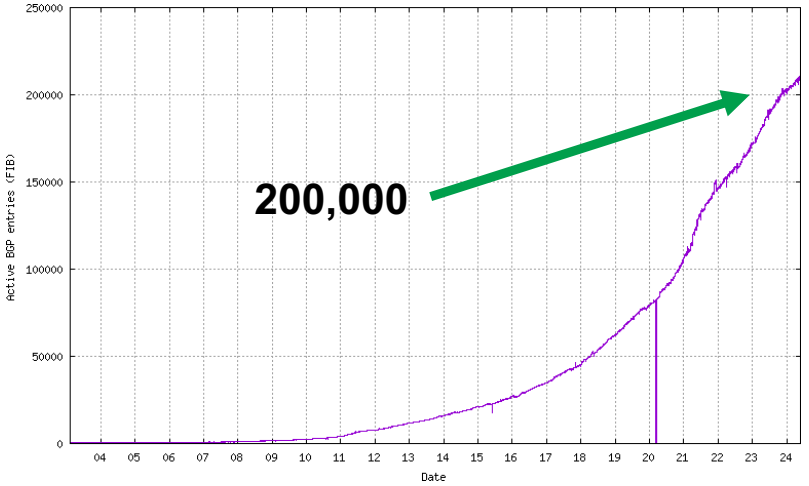
Carrier Grade NAT (CGN)



Global routing tables

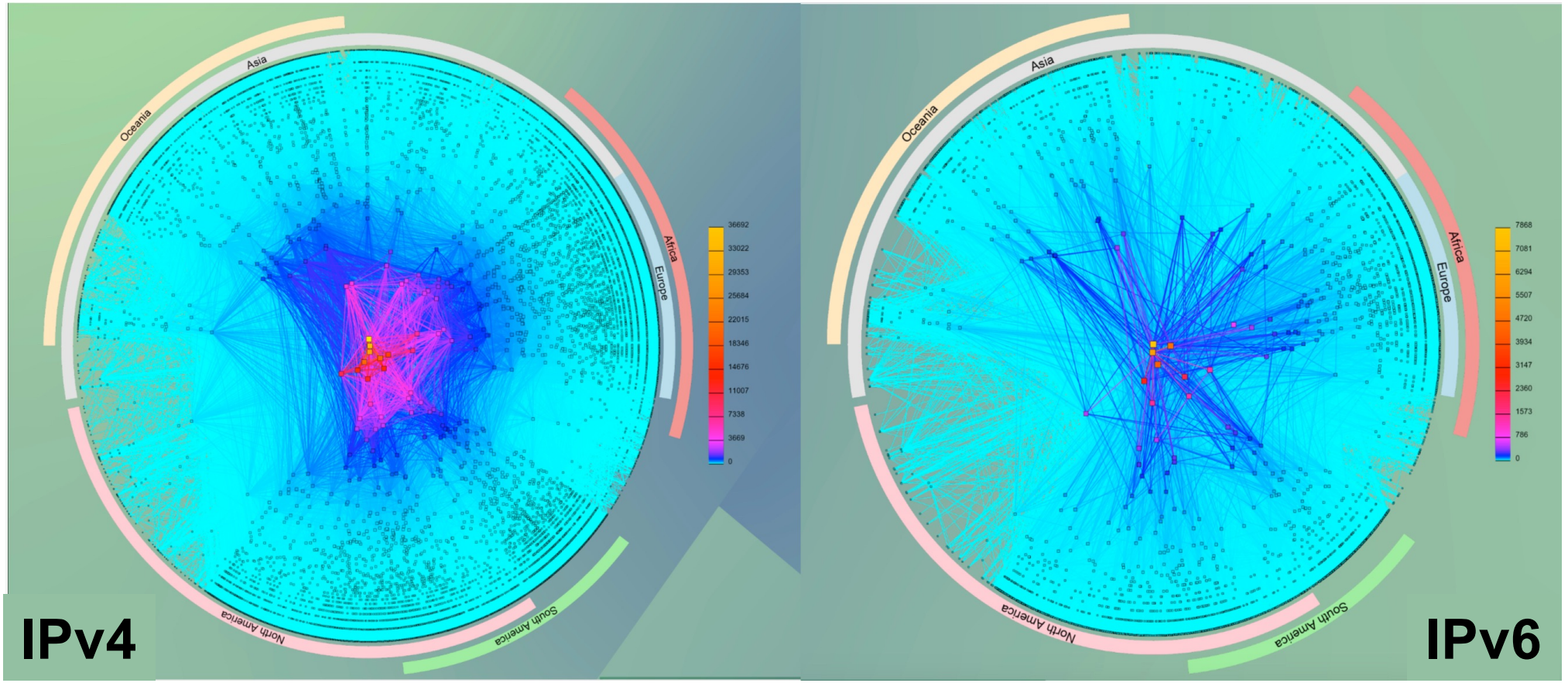


IPv4



IPv6

Latency: Global routing



Latency: Global routing

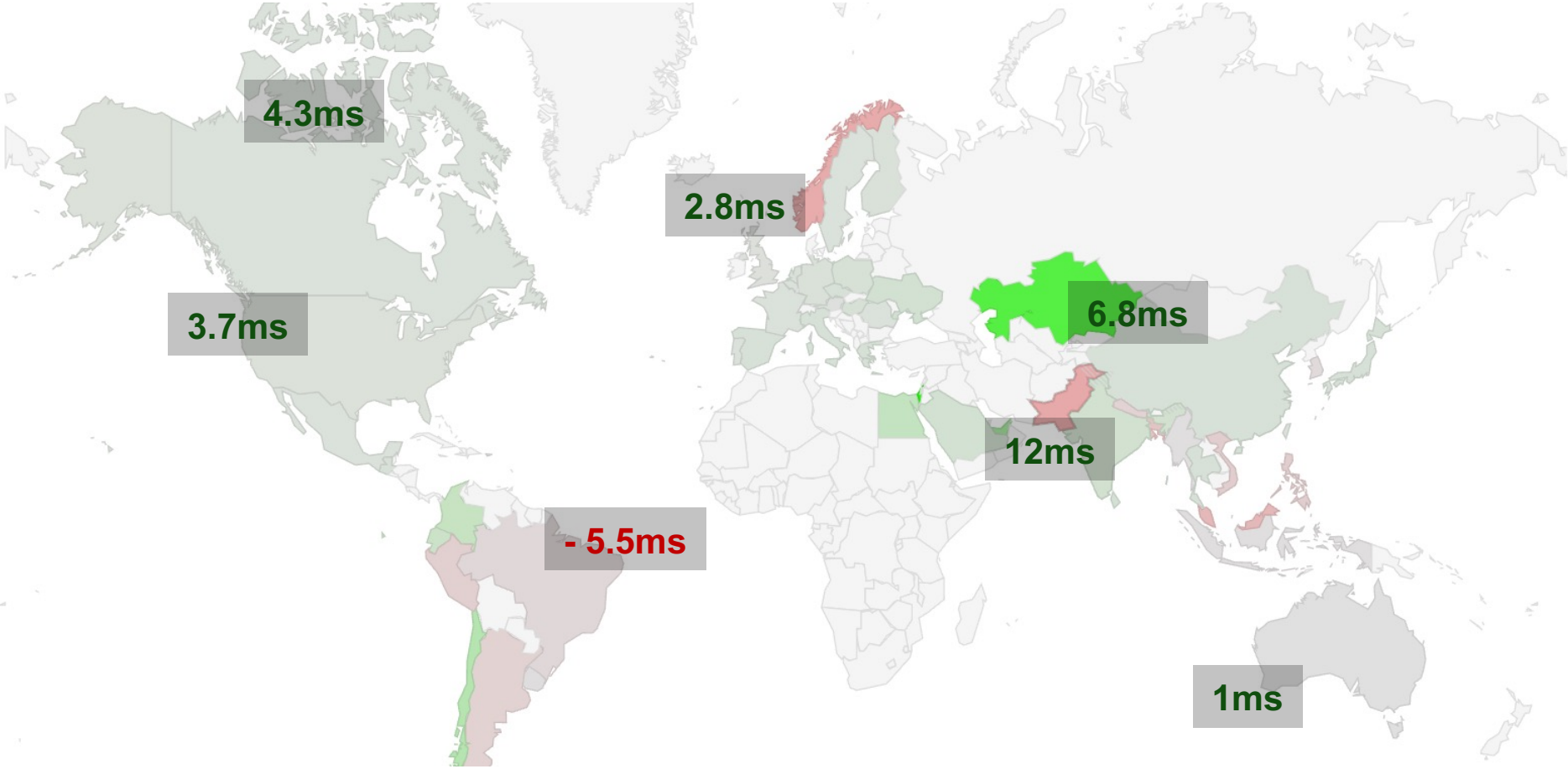
RIPE Labs

IPv4

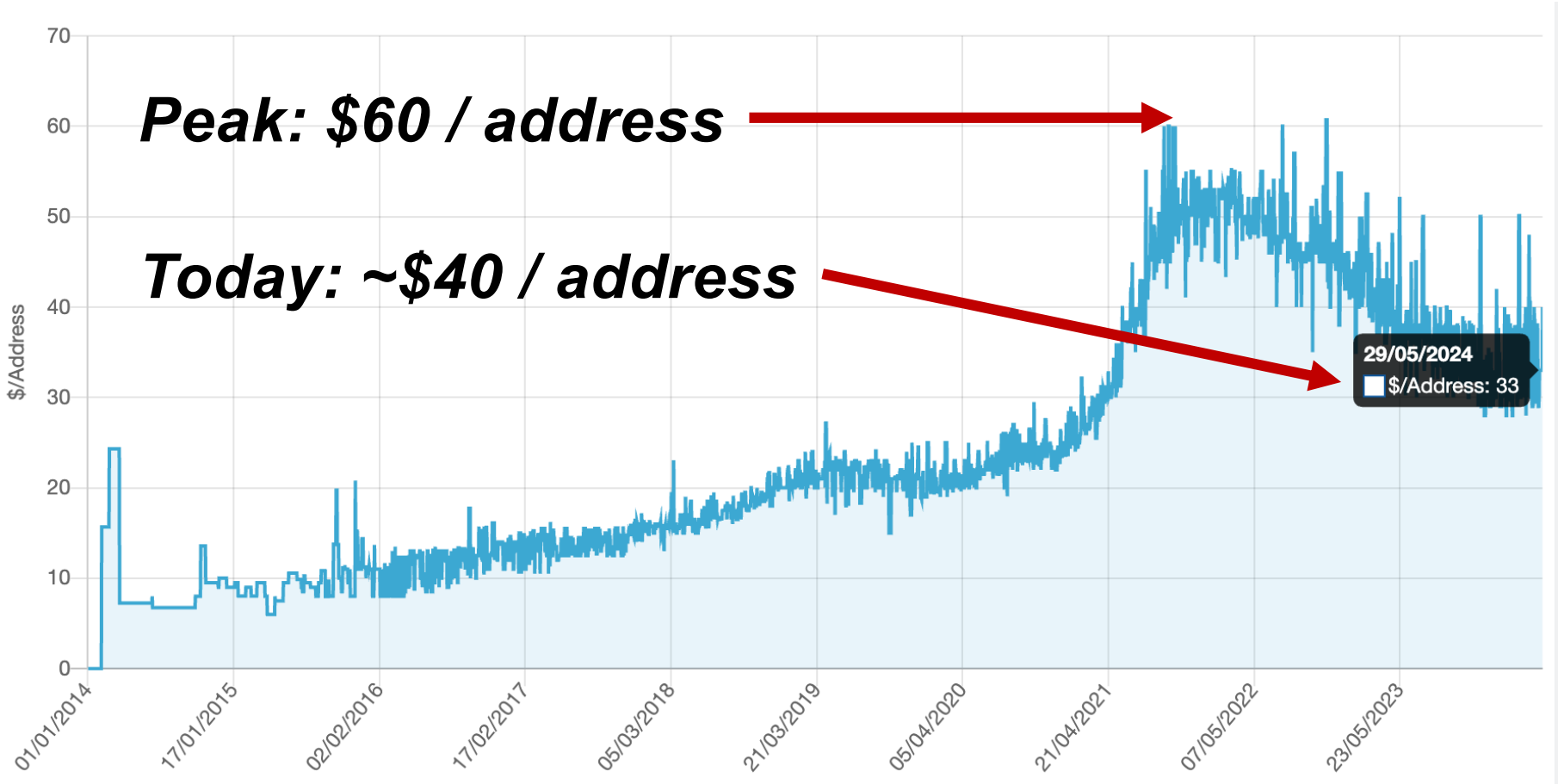
IPv6

AS Path length – Global average

Latency: IPv4 v IPv6

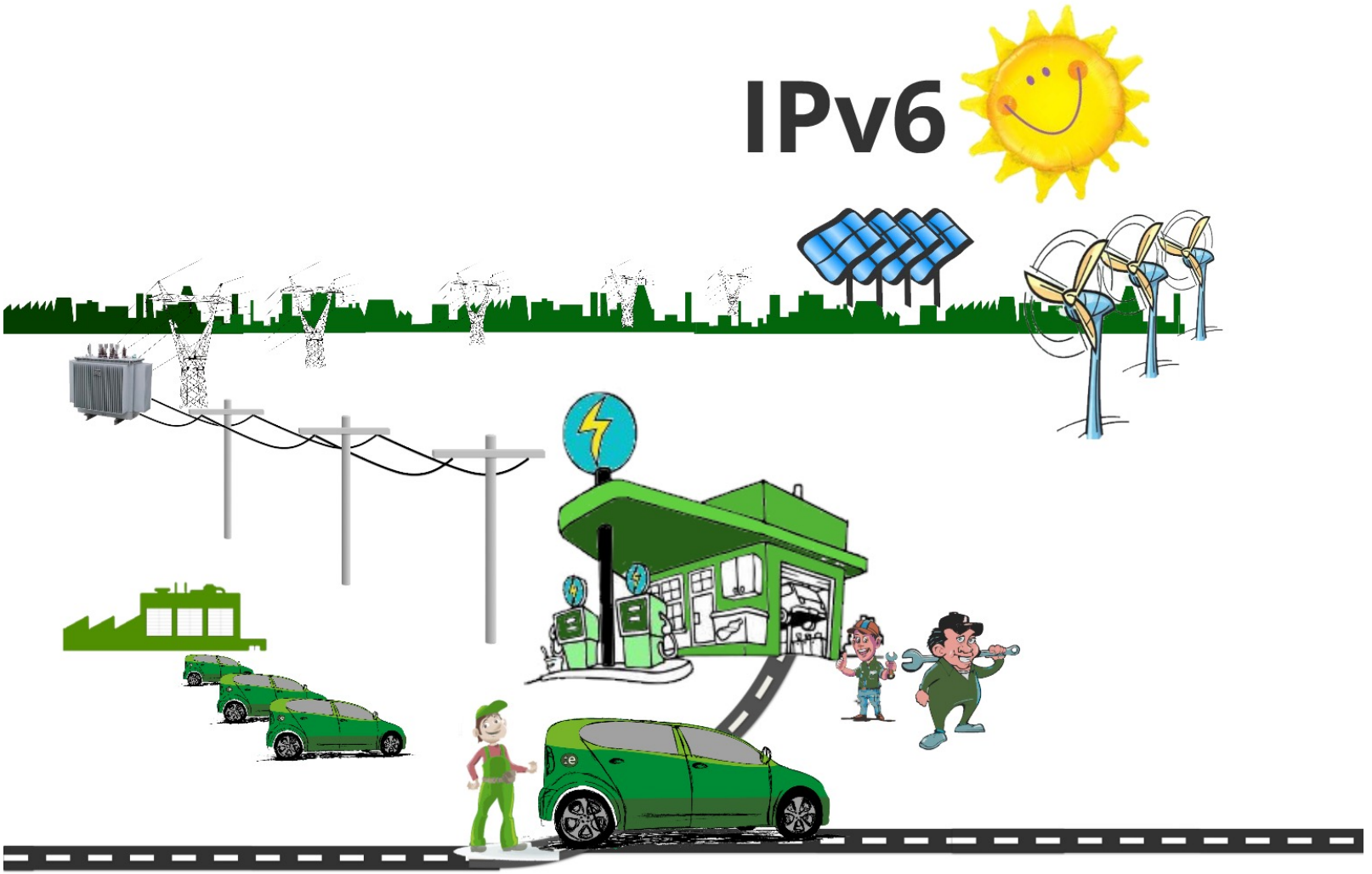


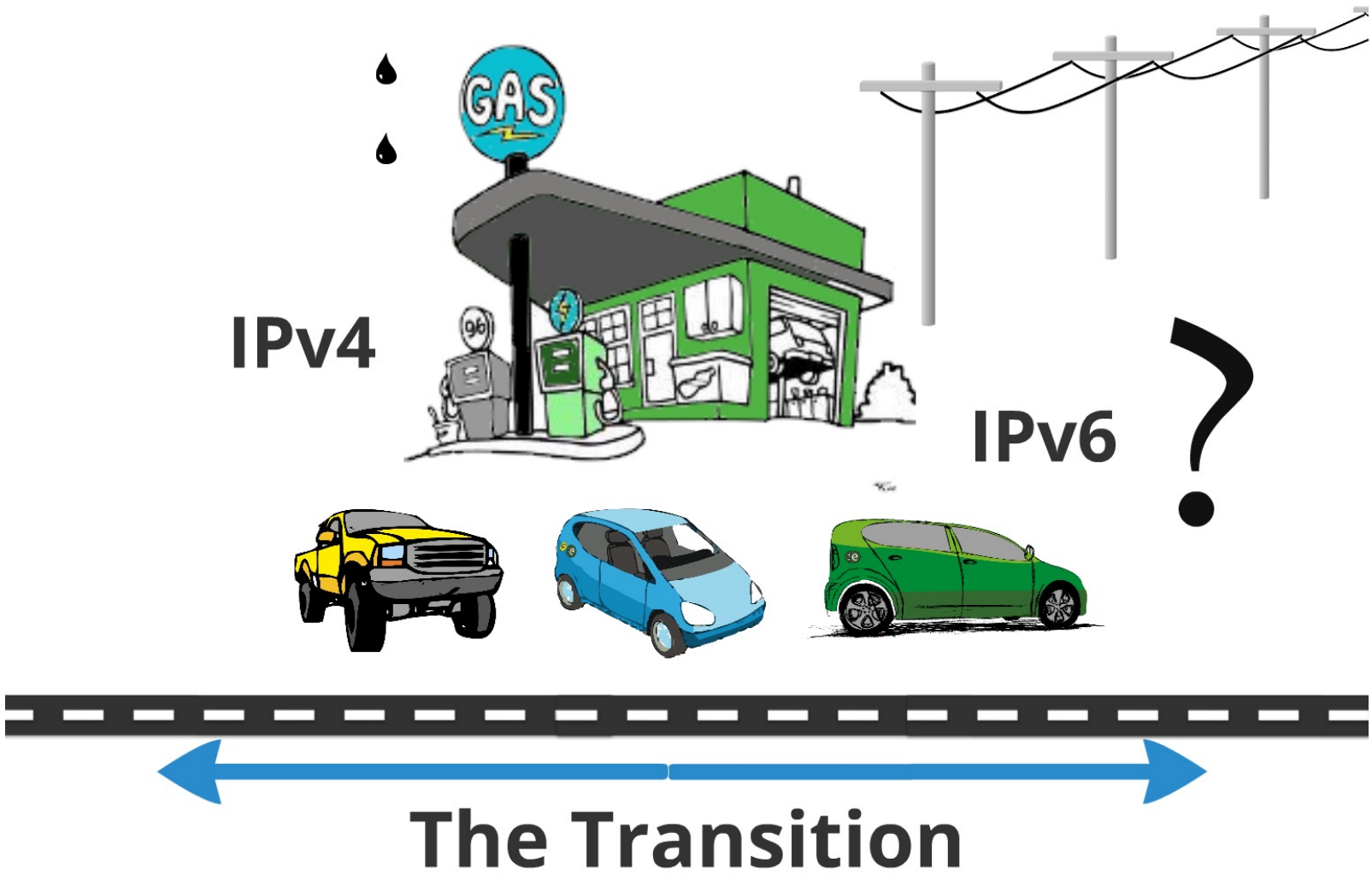
IPv4 market price



https://auctions.ipv4.global/prior-sales

IPv4


IPv6


GAS
IPv4
IPv6
?
The Transition

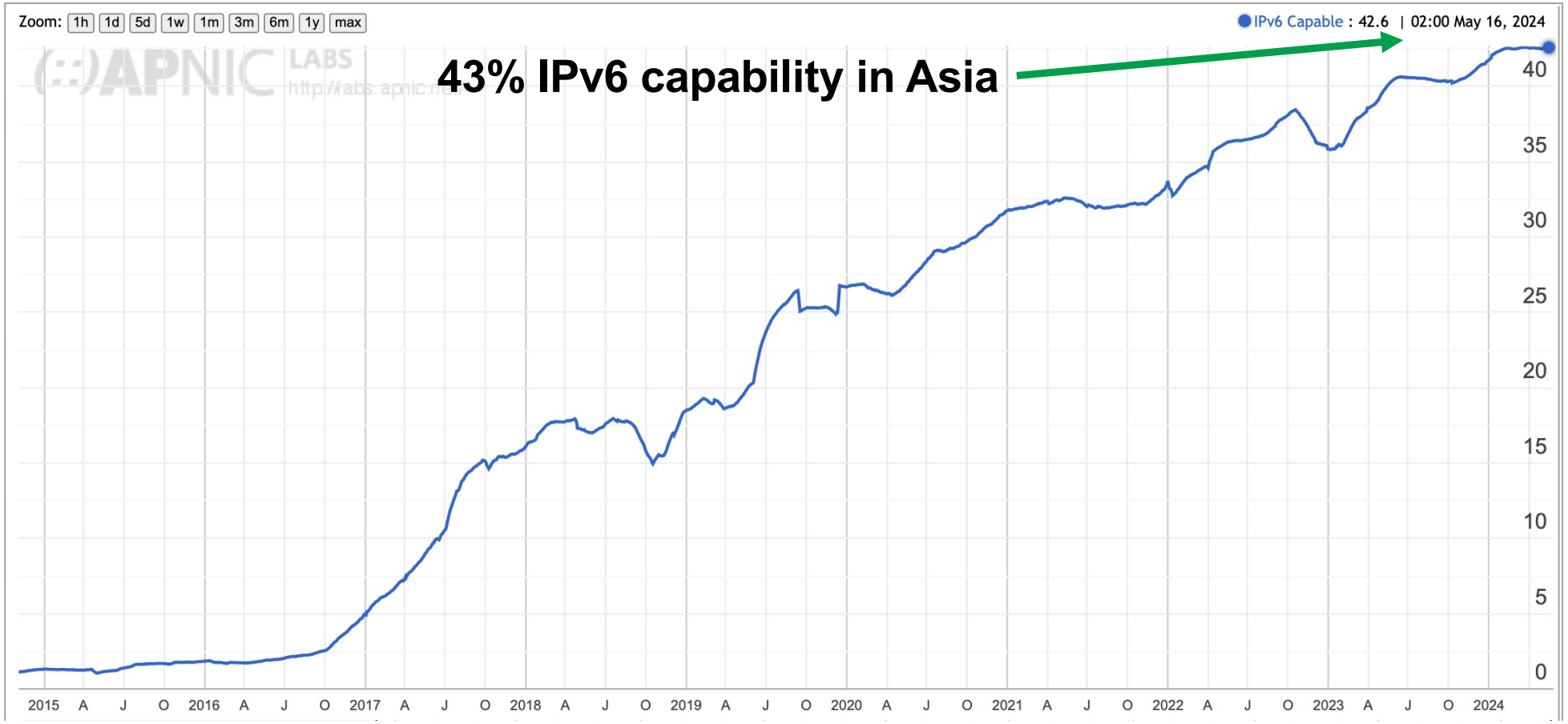
What drives deployment?

- Motivations
  - Supply of addresses: numbering, management, mergers
  - Cost of IPv4 (USD $40/address) vs cost of IPv6 (miniscule)
  - Cost of IPv4 NAT (USD $40/user/year?) vs no cost for native IPv6
  - Efficiency of technology and routing -> Lower latency
  - Competition and the network effect
- Doubts
  - Human capacity
  - Business risks, security and other FUD…
  - … natural resistance to change.

The Future: Good News!

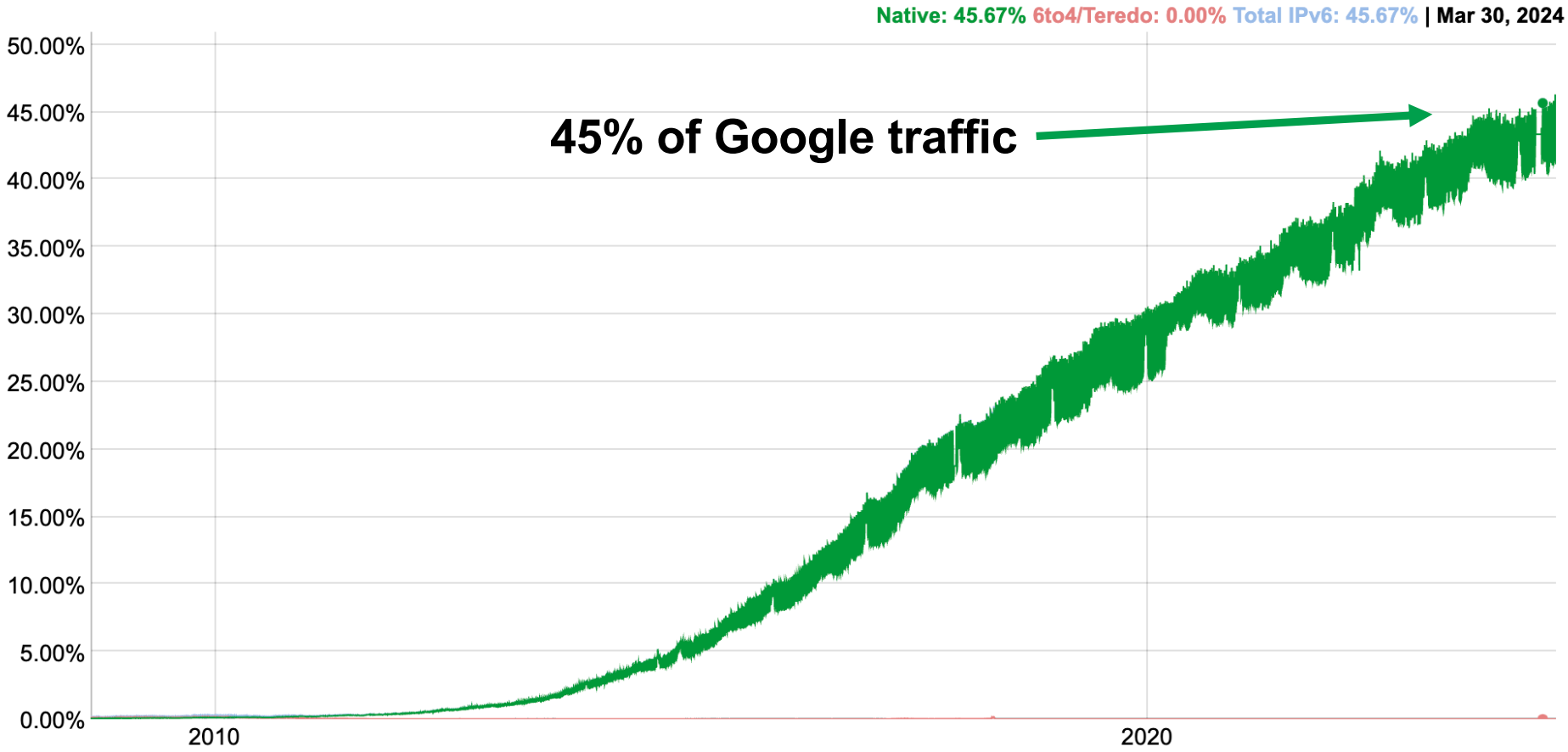
APNIC

Good news…



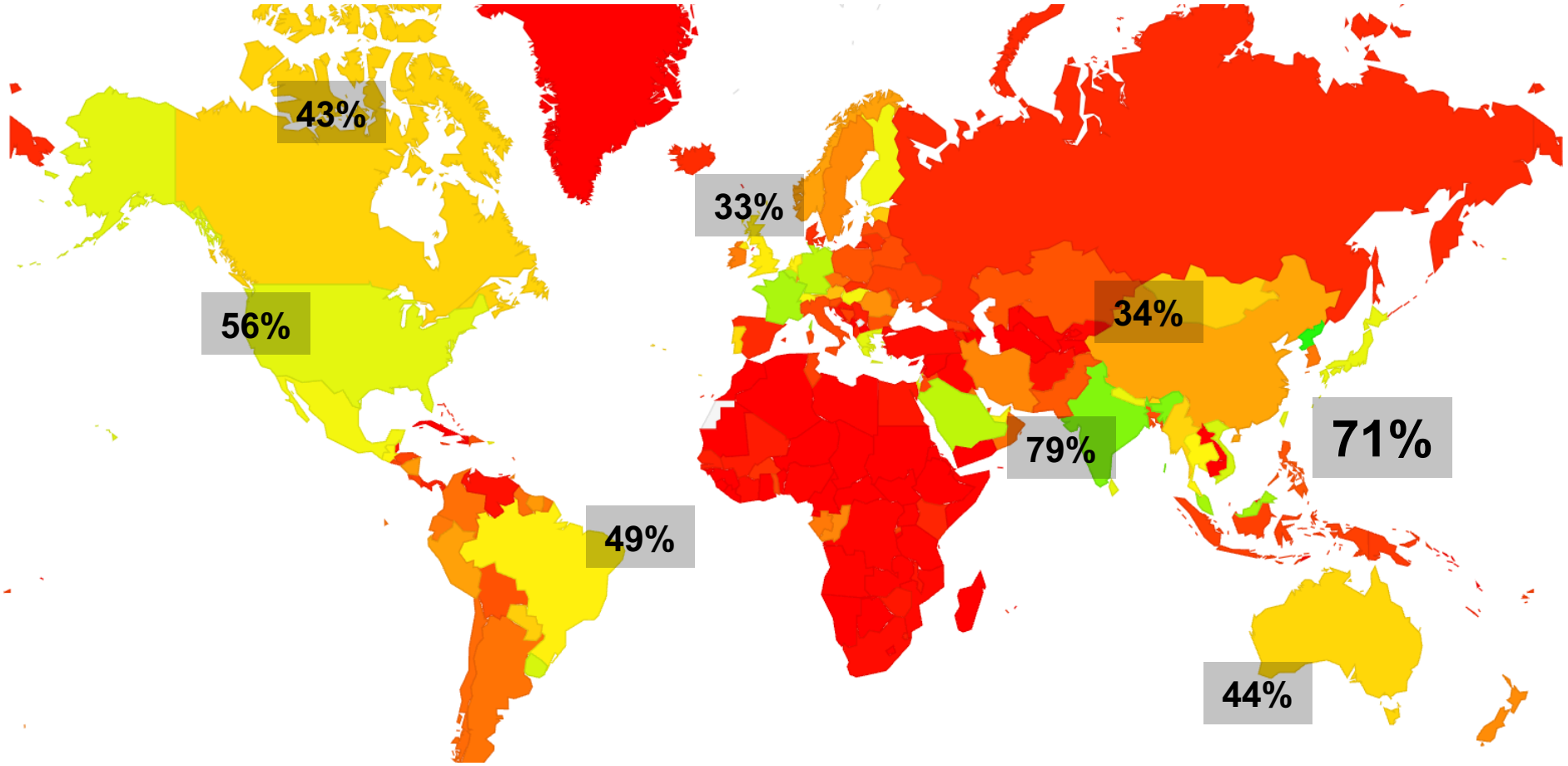
https://stats.labs.apnic.net/ipv6

More good news….



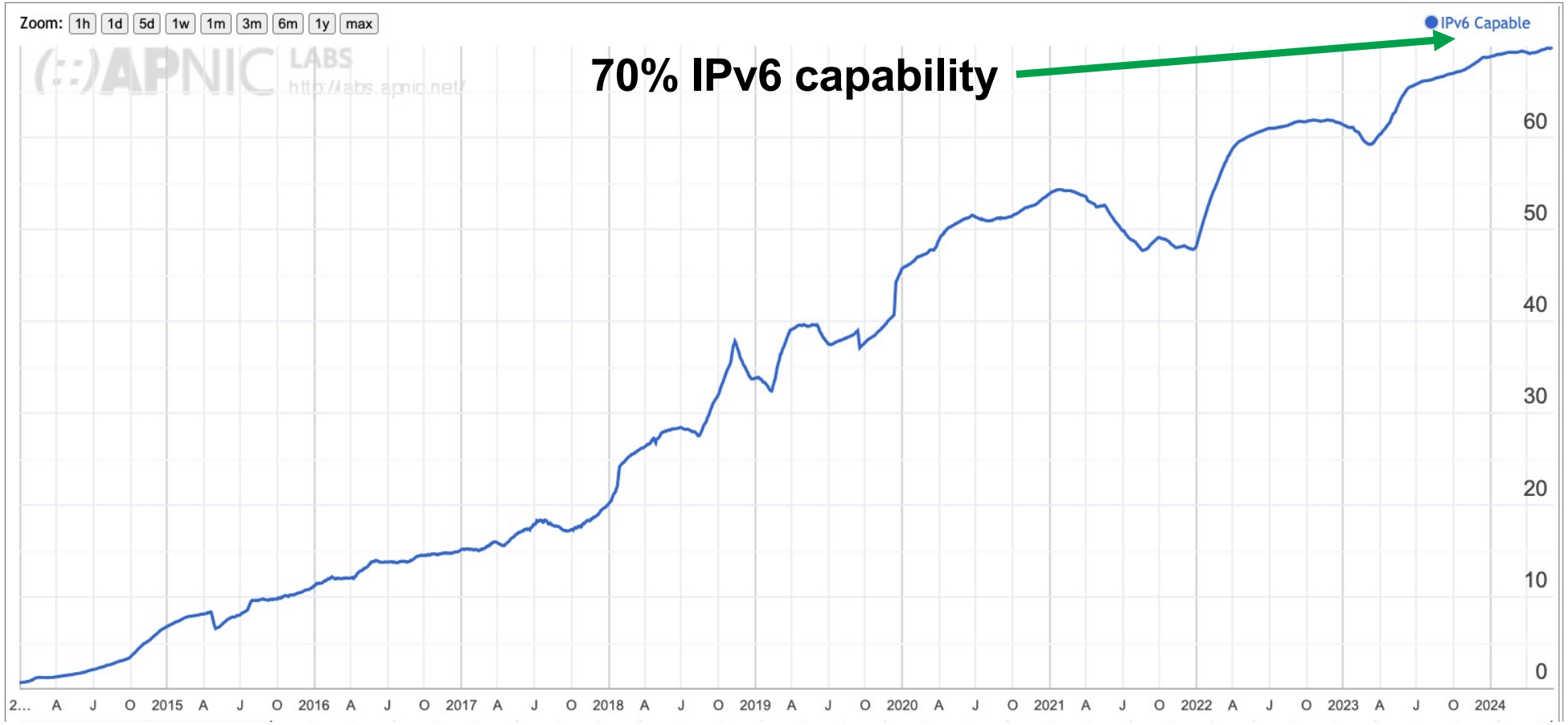
https://www.google.com/intl/en/ipv6/statistics.html

The global picture

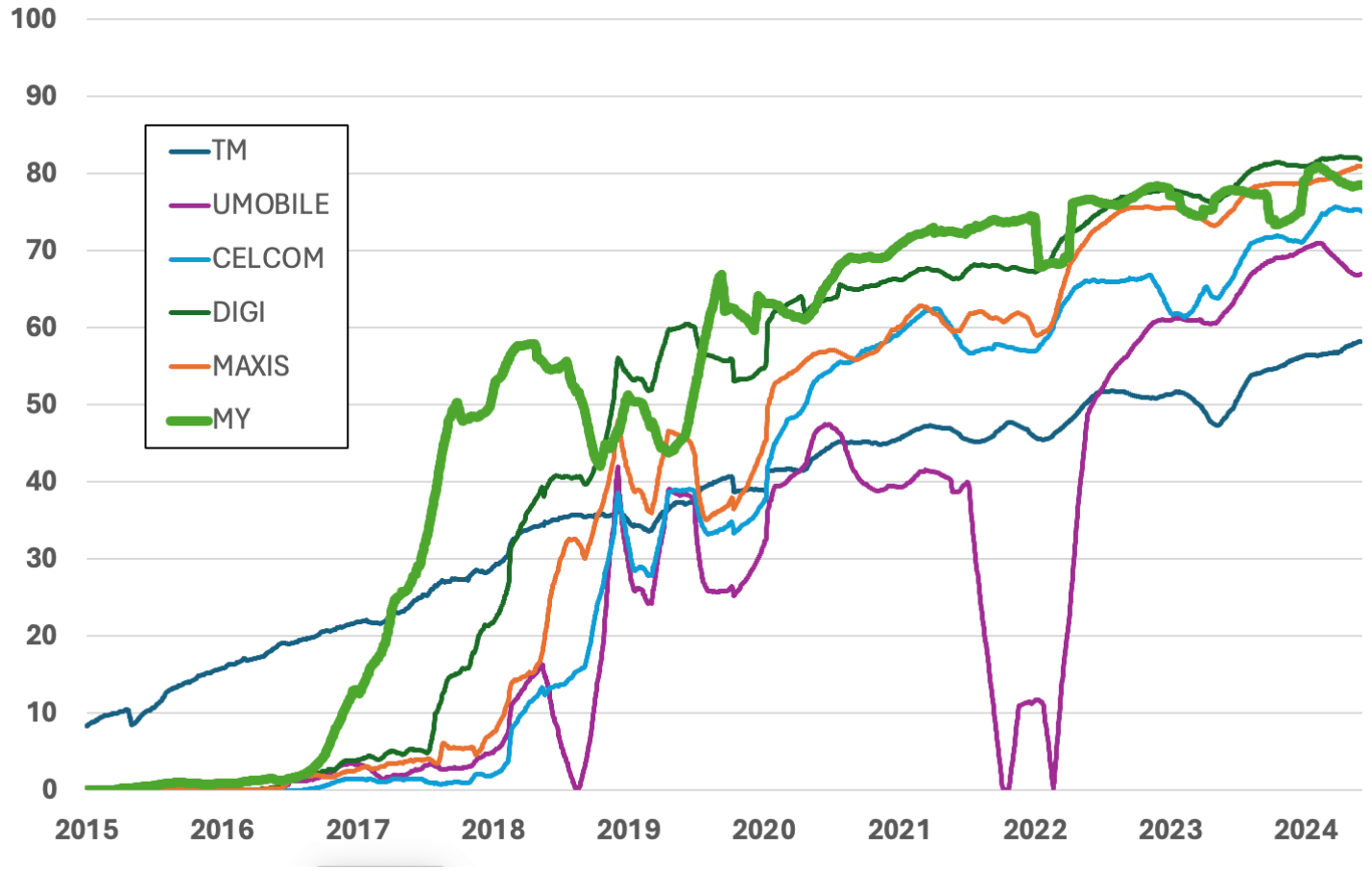


https://stats.labs.apnic.net/ipv6

Malaysian IPv6 capability



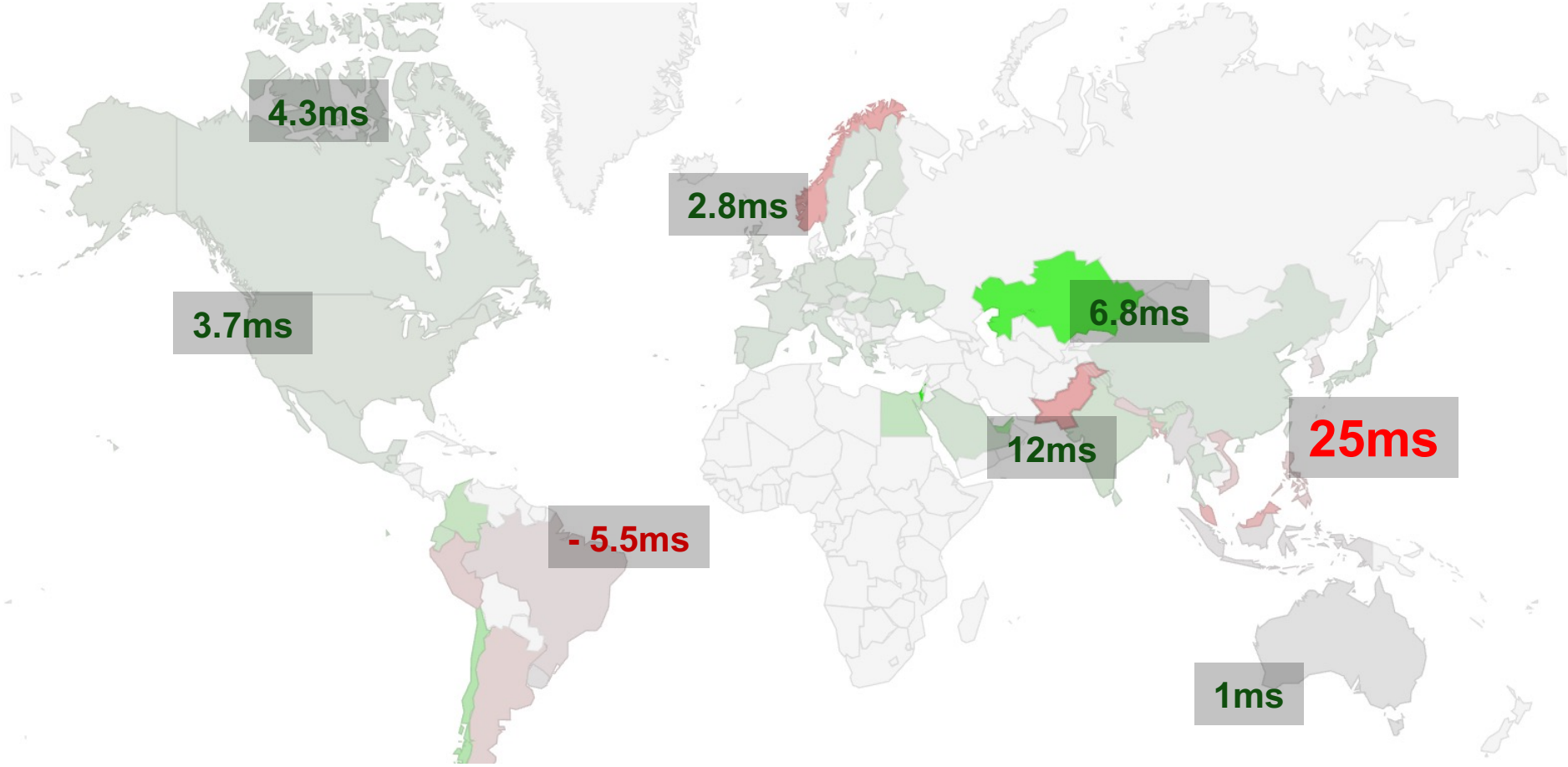
Malaysia's Top 5



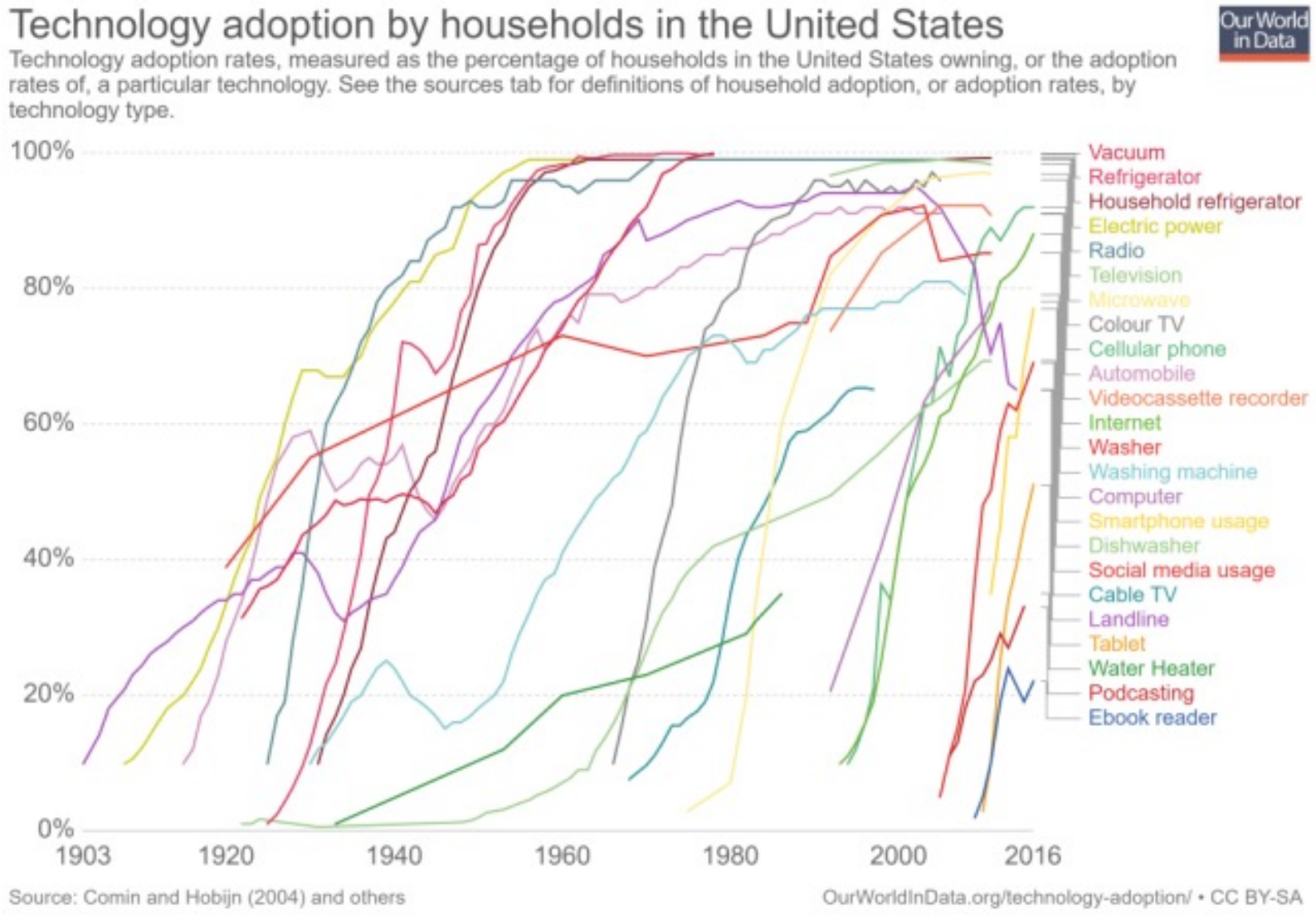
Malaysia's Top 10

ASN	AS Name	Capable	Samples
AS13335	CLOUDFLARENET	98.29%	21,449
AS4818	**DIGIIX-AP DiGi Telecommunications Sdn. Bhd.**	**83.22%**	**1,100,974**
AS9534	**MAXIS-AS1-AP Binariang Berhad**	**82.24%**	**1,497,195**
AS45960	YTLCOMMS-AS-AP YTL COMMUNICATIONS SDN BHD	77.31%	105,615
AS10030	**CELCOMNET-AP Celcom Axiata Berhad**	**75.87%**	**1,036,108**
AS9930	TTNET-MY TIME dotCom Berhad	71.26%	217,102
AS38322	TTSSB-MY TM TECHNOLOGY SERVICES SDN. BHD.	69.23%	82,005
AS38466	UMOBILE-AS-AP U Mobile Sdn Bhd	68.50%	833,431
AS4788	**TTSSB-MY TM TECHNOLOGY SERVICES SDN. BHD.**	**58.99%**	**2,206,887**
AS56231	ASTRO-MY-AS-AP MEASAT Broadcast Network Systems	15.58%	64,154

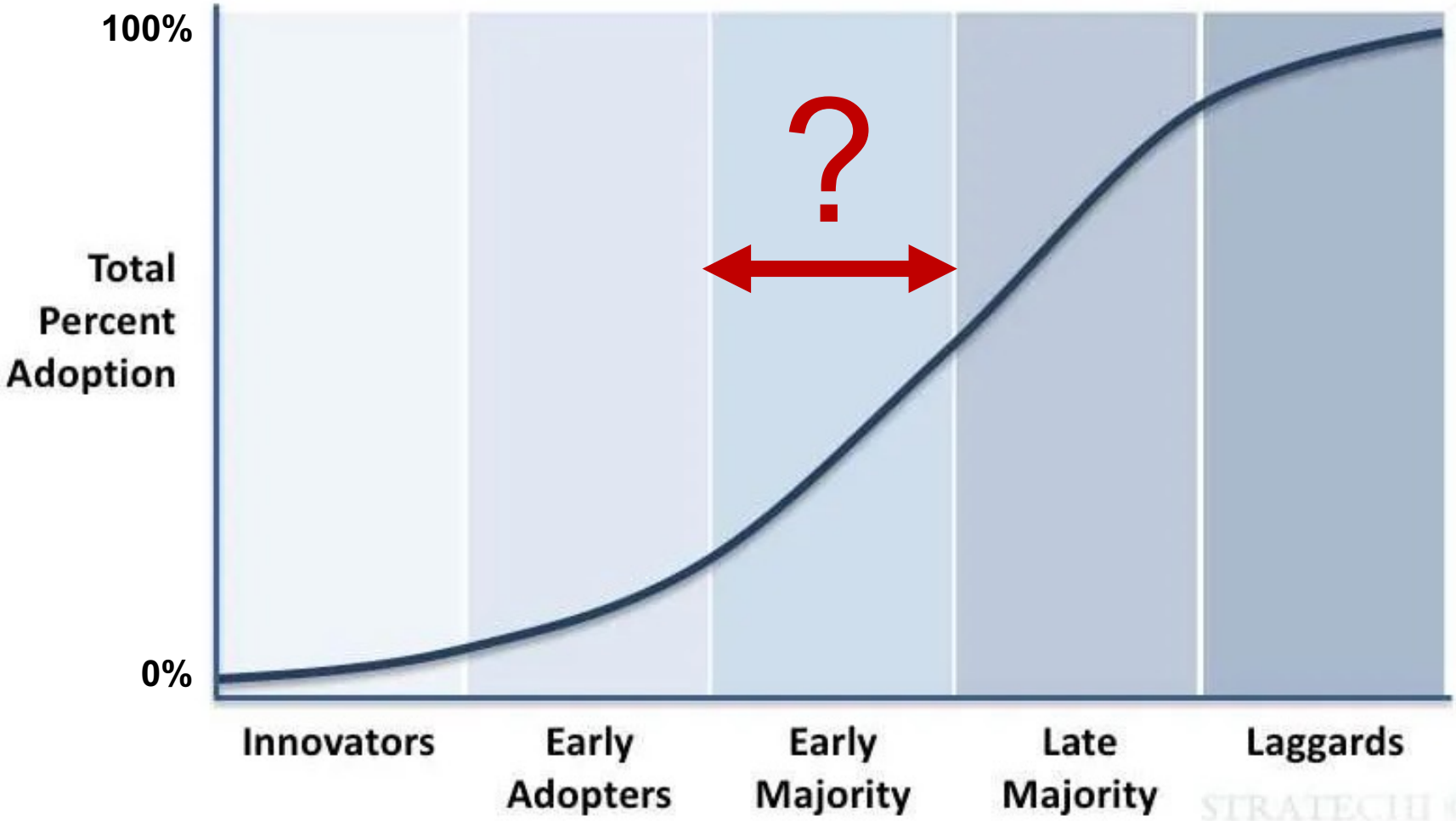
Latency: IPv4 v IPv6



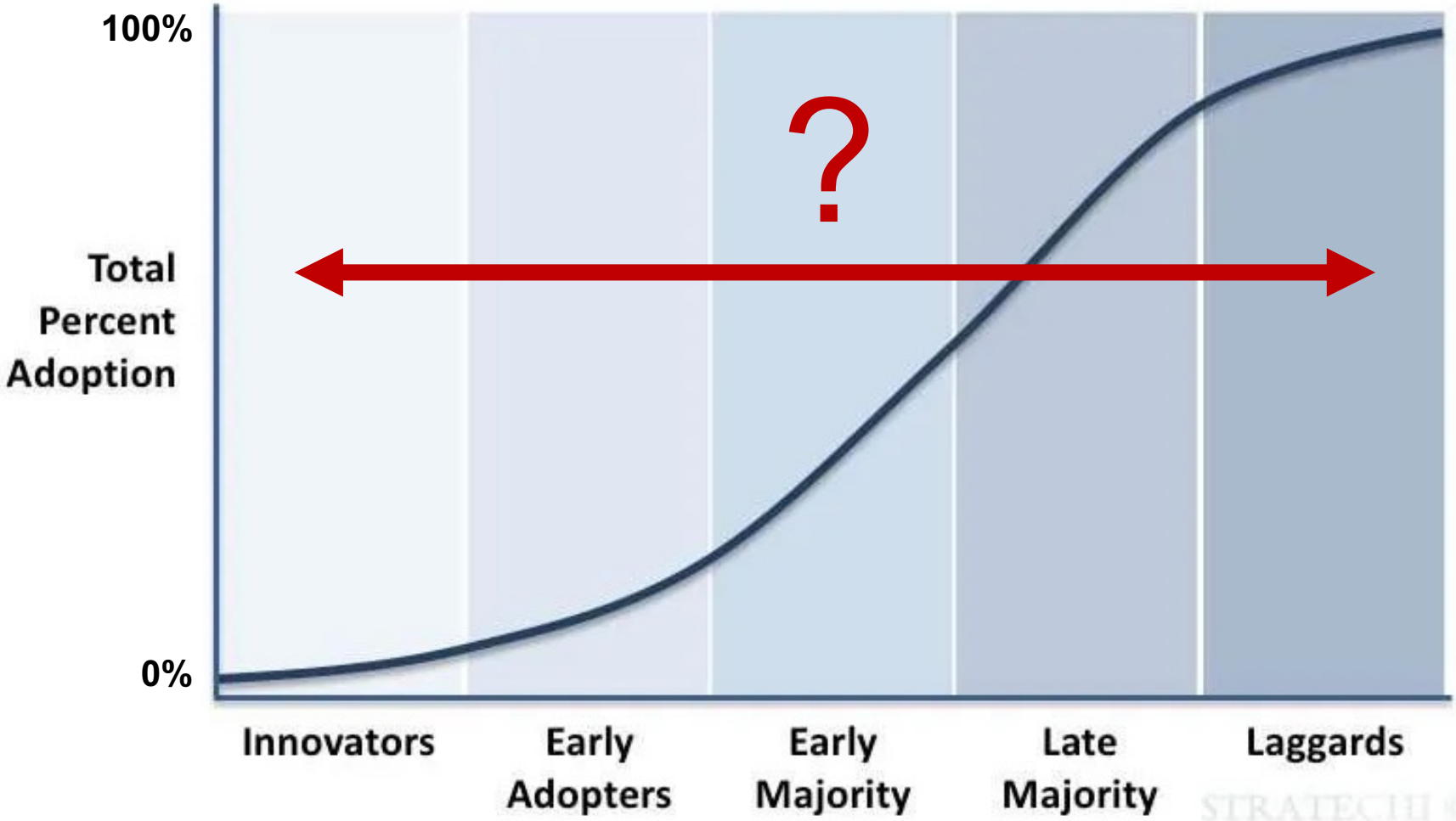
https://stats.labs.apnic.net/v6perf


Technology adoption by households in the United States
Technology adoption rates, measured as the percentage of households in the United States owning, or the adoption rates of, a particular technology. See the sources tab for definitions of household adoption, or adoption rates, by technology type.
Our World in Data
100%
80%
60%
40%
20%
0%
1903
1920
1940
1960
1980
2000
2016
Vacuum
Refrigerator
Household refrigerator
Electric power
Radio
Television
Microwave
Colour TV
Cellular phone
Automobile
Videocassette recorder
Internet
Washer
Washing machine
Computer
Smartphone usage
Dishwasher
Social media usage
Cable TV
Landline
Tablet
Water Heater
Podcasting
Ebook reader
Source: Comin and Hobijn (2004) and others
OurWorldInData.org/technology-adoption/ • CC BY-SA

Where are we on the IPv6 curve?



Where are YOU on the IPv6 curve?

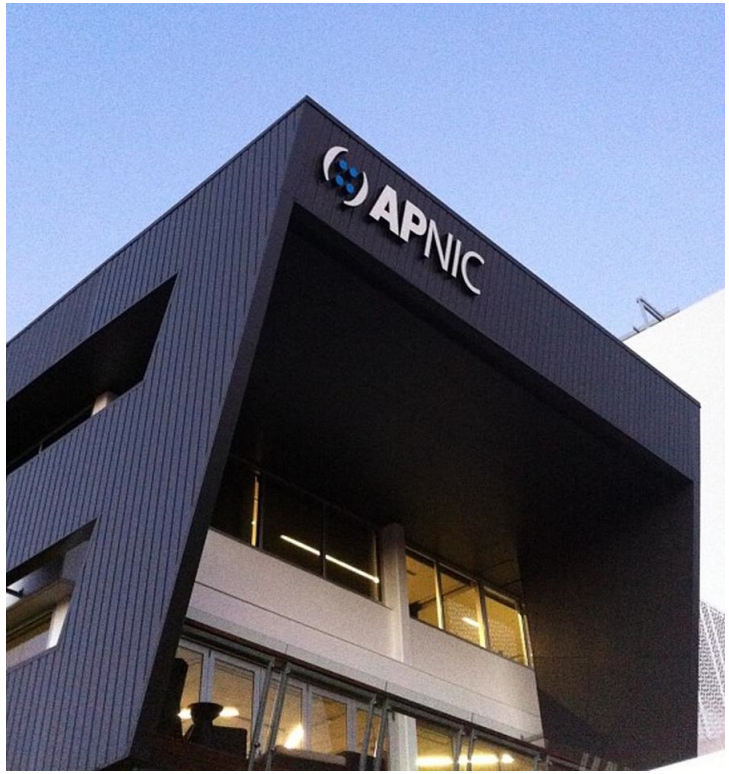


More about APNIC

APNIC

APNIC

- The RIR for the Asia Pacific region, since 1993
  - *For a "Global, Open, Stable and Secure Internet"*
- Delegates and manages Internet number resources
  - IPv4 and IPv6 addresses
  - AS numbers
- Agency for Internet development
  - Training, infrastructure, advocacy
- Membership-based, not-for-profit
  - Community self-regulatory body
  - Open, Neutral, Transparent, Trusted

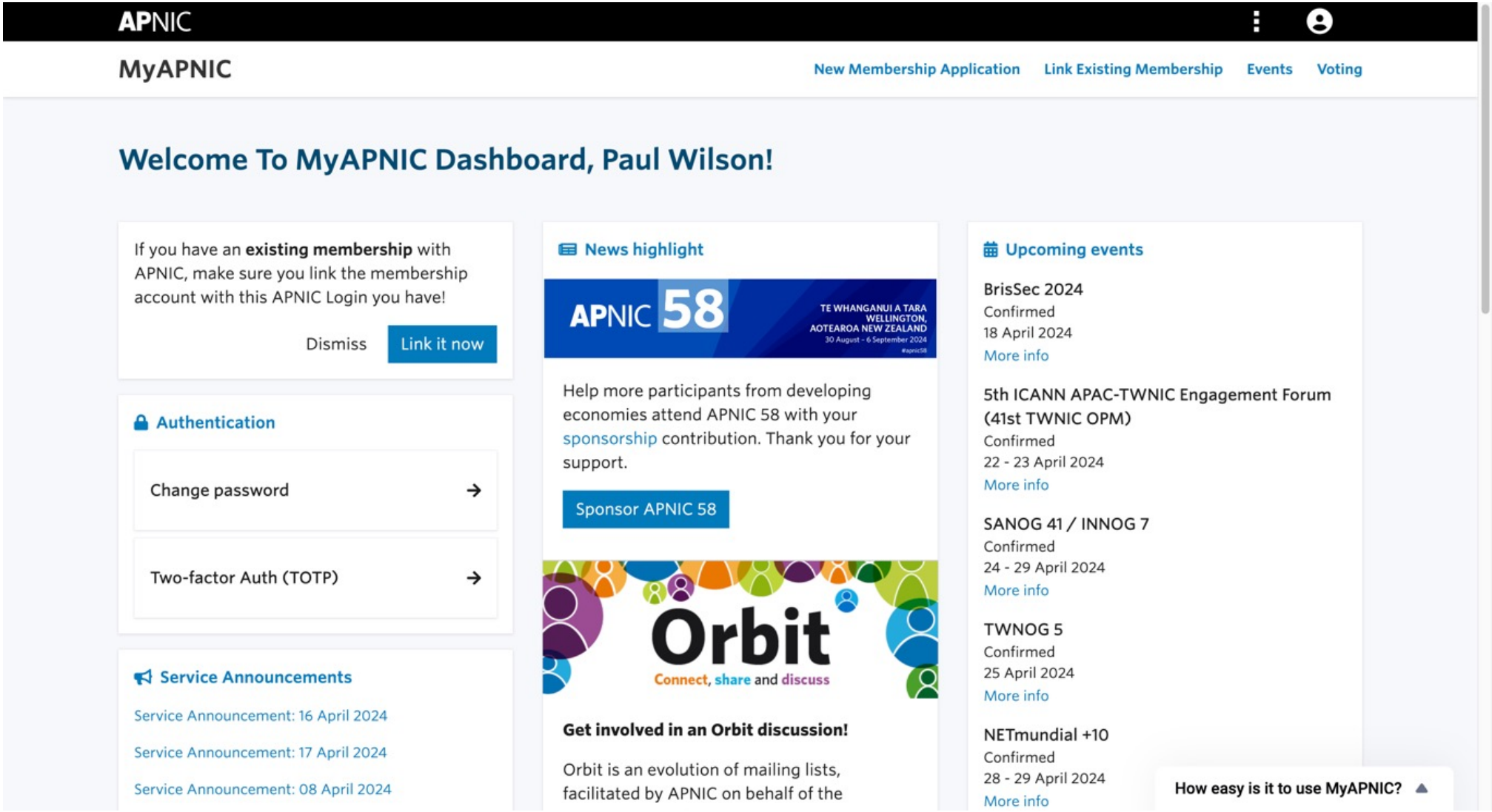


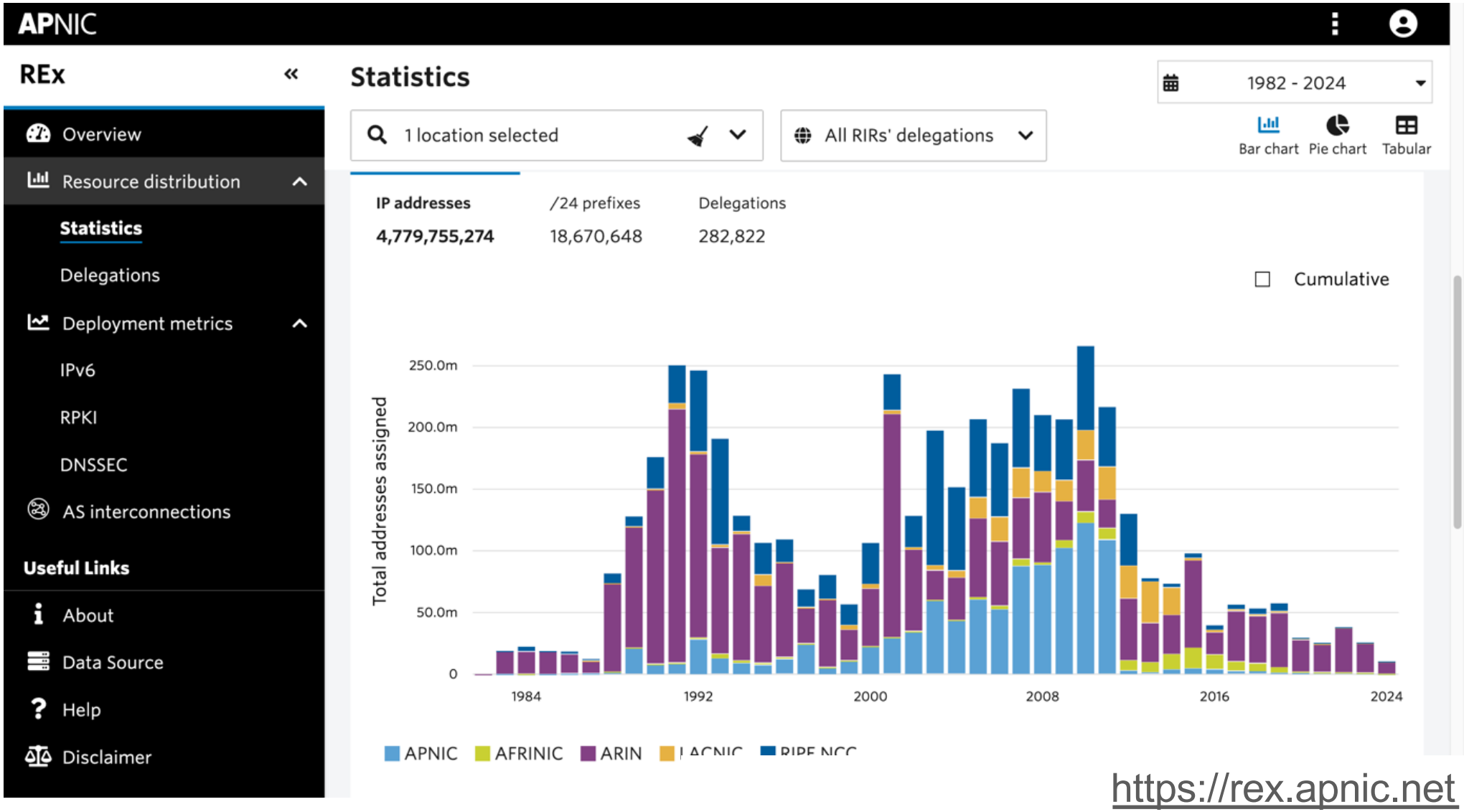
NIRs in the APNIC region

- National registries existed prior to APNIC…
  - JPNIC, CNNIC, KRNIC*, TWNIC*, AUNIC, NZNIC
- Some NIRs formed later
  - VNNIC, IRINN, IDNIC
- Some dissolved after APNIC formed
  - AUNIC, NZNIC
- NIR functions
  - “Agent” for RIR services according to APNIC policies
  - Interfacing with APNIC: Operations, Services and PDP
  - Other activities according to role and need
- ***“The economic conditions and benefits for the establishment of new NIRs have declined, and new NIRs are no longer sustainable” – APNIC EC, 2024***

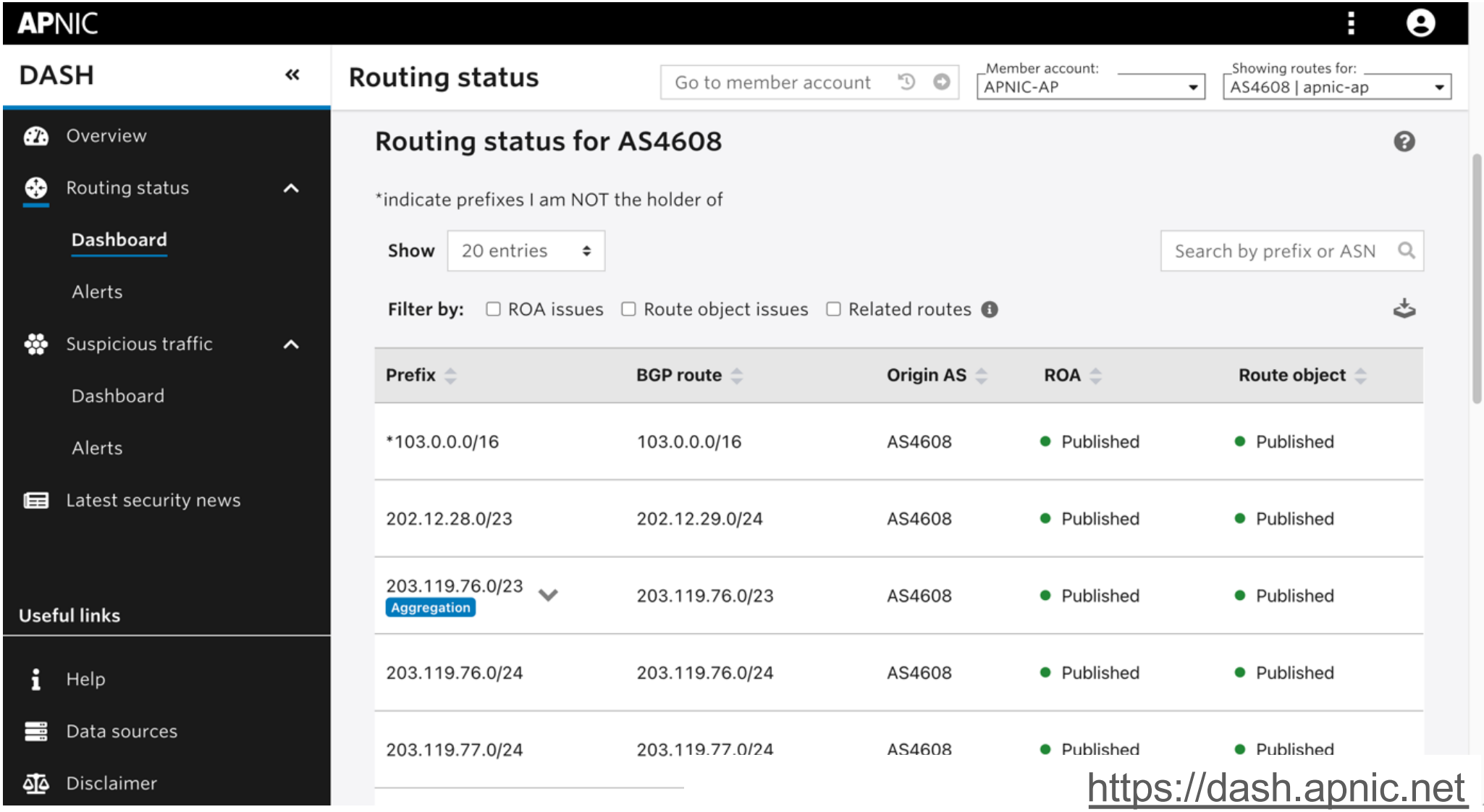
What else does APNIC do?

- Information products and services
  - APNIC Labs, APNIC Blog, Ping
  - Tools: Rex, DASH, Netox
- Representation
  - Defense of the Internet and its multistakeholder governance
  - Liaison: IETF, ICANN, ITU, APT, PITA, OECD, APEC TEL…
- Infrastructure support
  - IXPs and DNS rootservers
- Internet development
  - APNIC Academy
  - APNIC Foundation (2016)
  - Asia Pacific Internet Development Trust (2021)


APNIC
MyAPNIC
New Membership Application
Link Existing Membership
Events
Voting
Welcome To MyAPNIC Dashboard, Paul Wilson!
If you have an existing membership with APNIC, make sure you link the membership account with this APNIC Login you have!
Dismiss
Link it now
Authentication
Change password
Two-factor Auth (TOTP)
Service Announcements
Service Announcement: 16 April 2024
Service Announcement: 17 April 2024
Service Announcement: 08 April 2024
News highlight
APNIC 58
TE WHANGANUI A TARA WELLINGTON, AOTEAROA NEW ZEALAND
30 August - 6 September 2024
Help more participants from developing economies attend APNIC 58 with your sponsorship contribution. Thank you for your support.
Sponsor APNIC 58
Orbit
Connect, share and discuss
Get involved in an Orbit discussion!
Orbit is an evolution of mailing lists, facilitated by APNIC on behalf of the
Upcoming events
BrisSec 2024
Confirmed
18 April 2024
More info
5th ICANN APAC-TWNIC Engagement Forum (41st TWNIC OPM)
Confirmed
22 - 23 April 2024
More info
SANOG 41 / INNOG 7
Confirmed
24 - 29 April 2024
More info
TWNOG 5
Confirmed
25 April 2024
More info
NETmundial +10
Confirmed
28 - 29 April 2024
More info
How easy is it to use MyAPNIC?



https://rex.apnic.net



https://dash.apnic.net

Technical Community 2023

- 41 community events
  - 25 NOGs: Sponsorship, speakers, training and technical support
- 22 security events
  - 4 threat sharing events
  - BtCIRT, KrCERT/CC, CERT VU, CERT NZ, Fiji CERT, MNCERT/CC
  - Mentoring at FIRST Annual Conference 2023

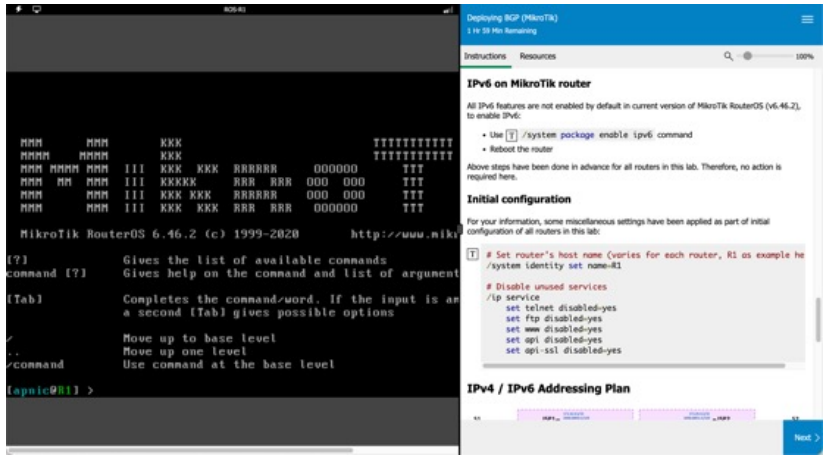
APNIC Academy 2023

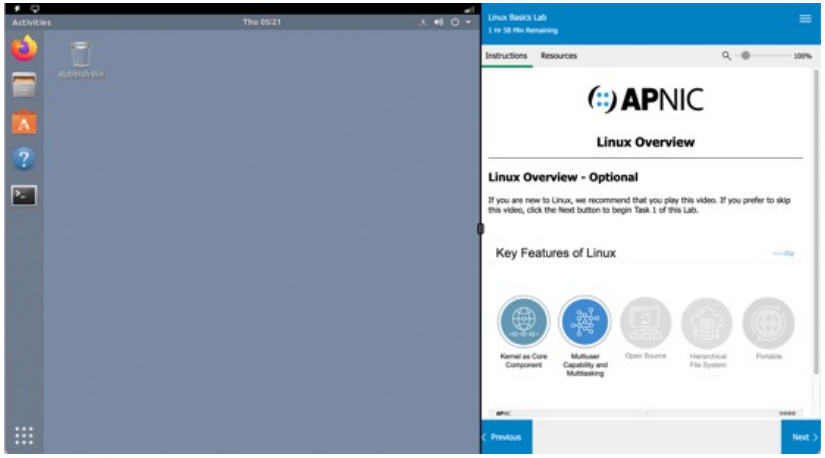
- Instructor-led training
  - 30+ events (incl 16 NOGs)
  - 40 online tutorials
- New online, self-paced courses
  - Cybersecurity Fundamentals
  - Introduction to BGP
- Virtual Labs
  - 11 new DNS, BGP, RPKI, IXPs etc
  - RPKI and Linux labs updated
- 33 Volunteer, 10 Retained CTs

	Instructor-led	Self-paced
Courses	Face-to-face: 80 Online/Hybrid: 108	2,816 completions; 5,999 hours
Students	4,782	9,743 new 34,333 total
Virtual Labs		21,064 labs 25,548 hours


LANOG 1.0

apnic.academy





APNIC Foundation

https://apnic.foundation

isif.asia

2024 ISIF Asia grant[illegible]pen f[illegible] applications

The A[illegible]C F[illegible]tion is [illegible]d t[illegible]nno[illegible]ce th[illegible] 2[illegible]24 [illegible]f I[illegible]ia grants [illegible] op[illegible] f[illegible] applications.

[illegible]s of USD 30,000, USD [illegible]5,000 and USD 150,000 will be available across the areas of Infrastructure, Inclusion and Knowledge.

Additionally, there are grants available for up to USD 250,000 for infrastructure projects that tackle IPv6 deployment.

Find out more on the blog, or apply now!

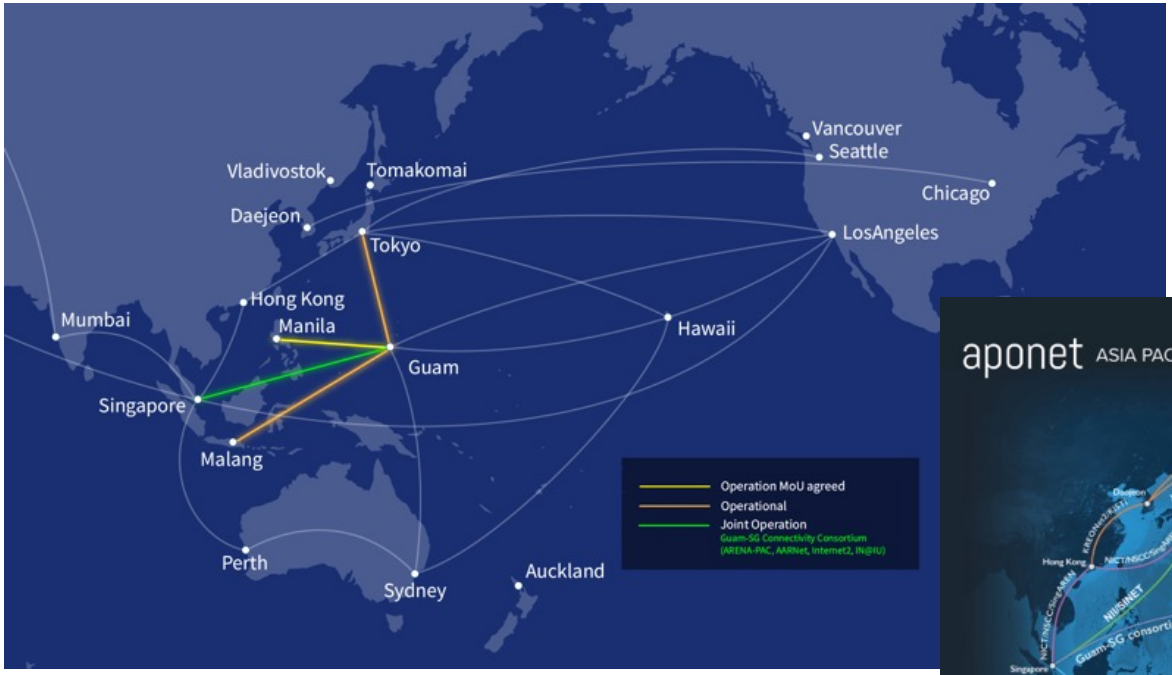
Back in 2025!

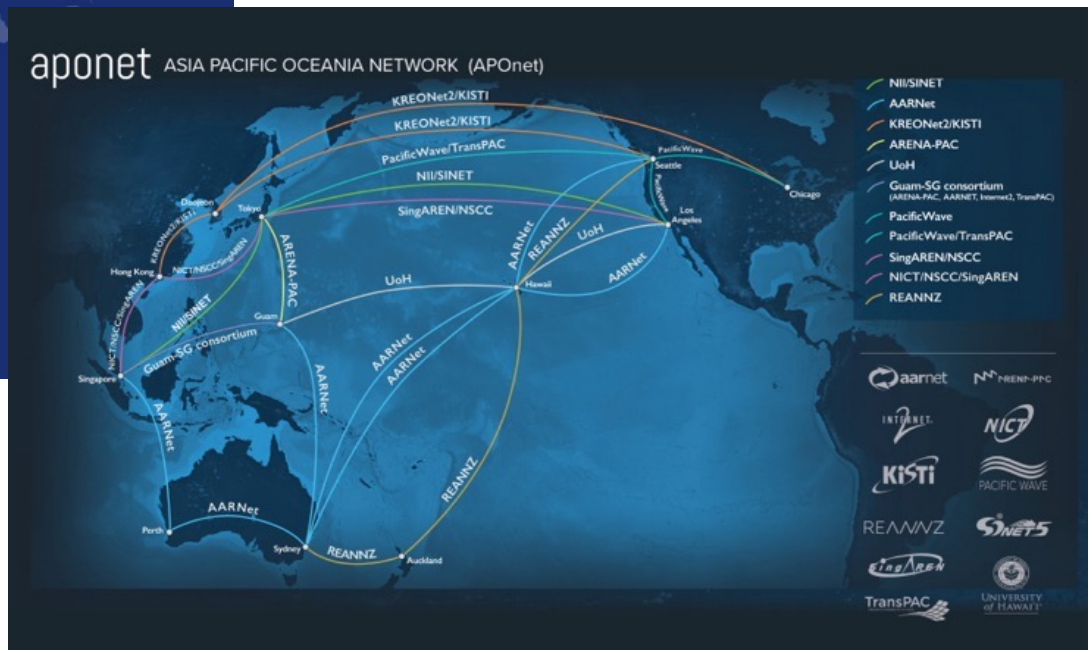
ASIA PACIFIC INTERNET DEVELOPMENT TRUST

Trustees Development Partners Documents News Contact

Funding Asia Pacific Internet Development

arena-pac.net





APNIC 58

- Wellington, New Zealand, with **Pacific IGF**
  - Workshops: 30 August to 2 September
  - Conference: 4 to 6 September 2024
  - Fellowships available!

https://conference.apnic.net/58

That’s all folks!

Questions?

http://www.apnic.net

APNIC