IPv6:
Where are we now?

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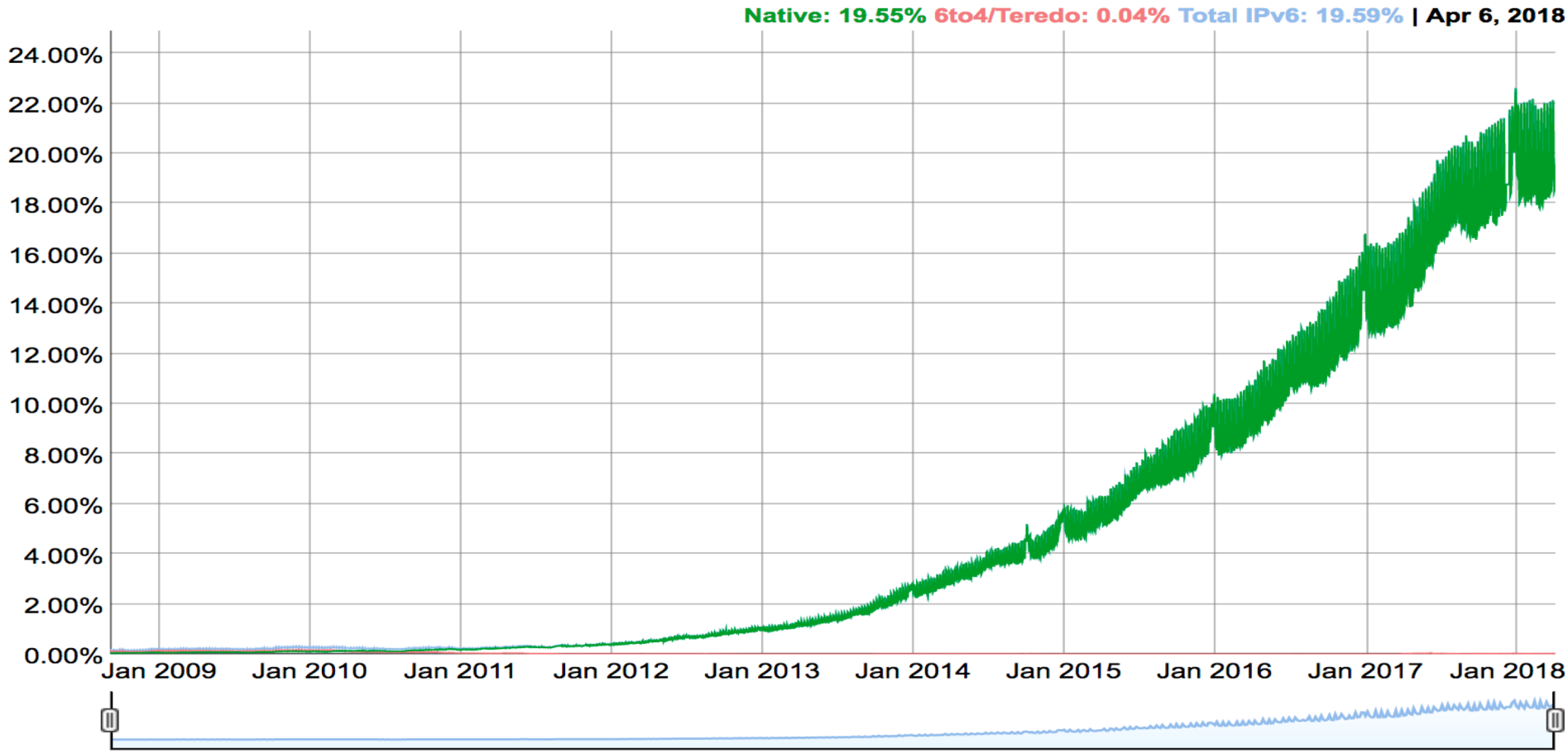
IPv6 adoption stats - Google

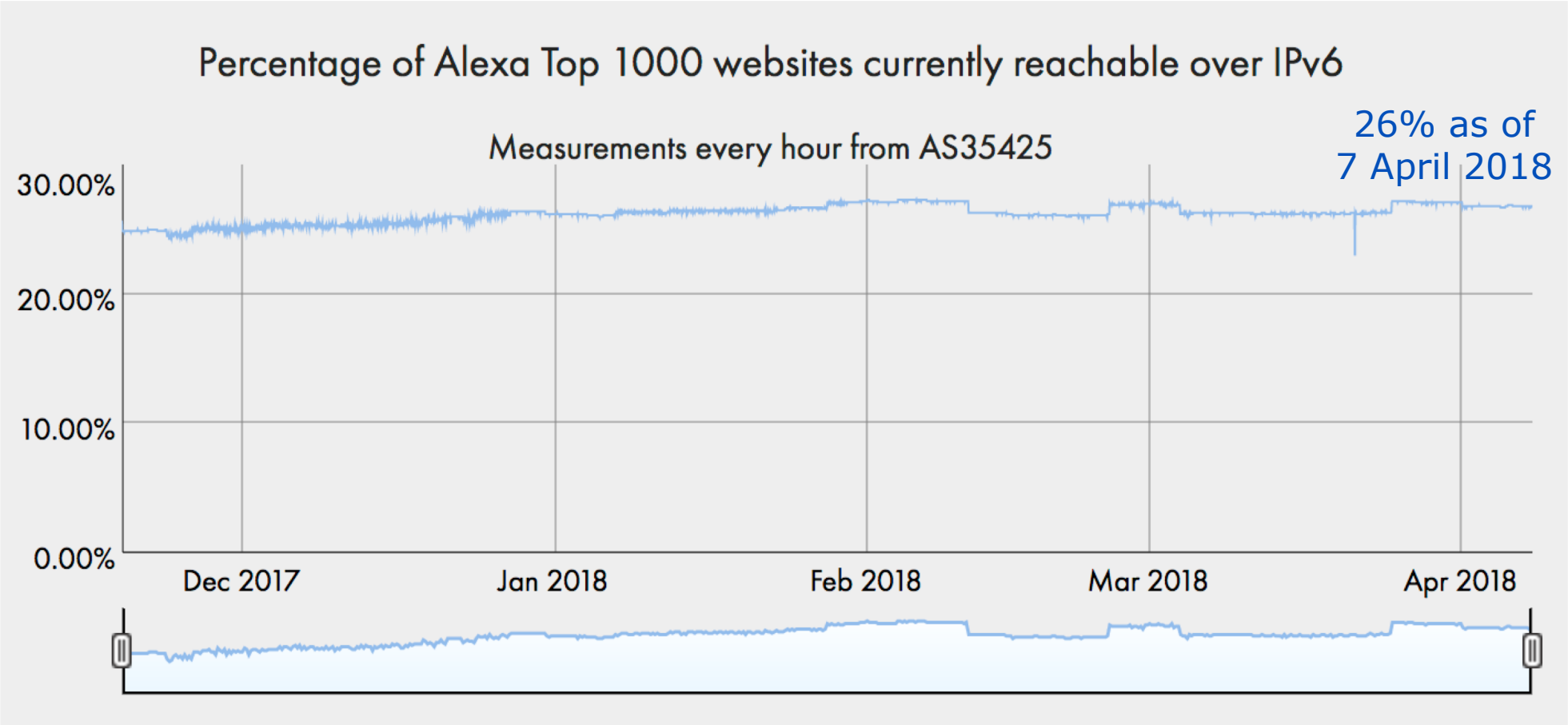
IPv6 Adoption

We are continuously measuring the availability of IPv6 connectivity among Google users. The graph shows the percentage of users that access Google over IPv6.



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

Top 1000 websites - IPv6



http://www.worldipv6launch.org/measurements/

End-user readiness - APNIC Labs

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

How we measure

- Uses advertisement to load measurement script (HTML5/flash) on user's browser
  - Over 2M measurements/day!!
- Script fetches three invisible pixels
  - IPv4 only URL
  - IPv6 only URL
  - Dual-stack URL
- If:
  - Fetches IPv6 URLs (native/dual-stack) over IPv6, device is deemed IPv6 capable
  - Fetches the dual-stack URL using IPv6, its deemed to prefer IPv6 (HE bias – RFC6555?)
    - Only Chrome – 300ms (Firefox and Opera parallel; OS X and iOS – 25ms)

IPv6 table - Oceania

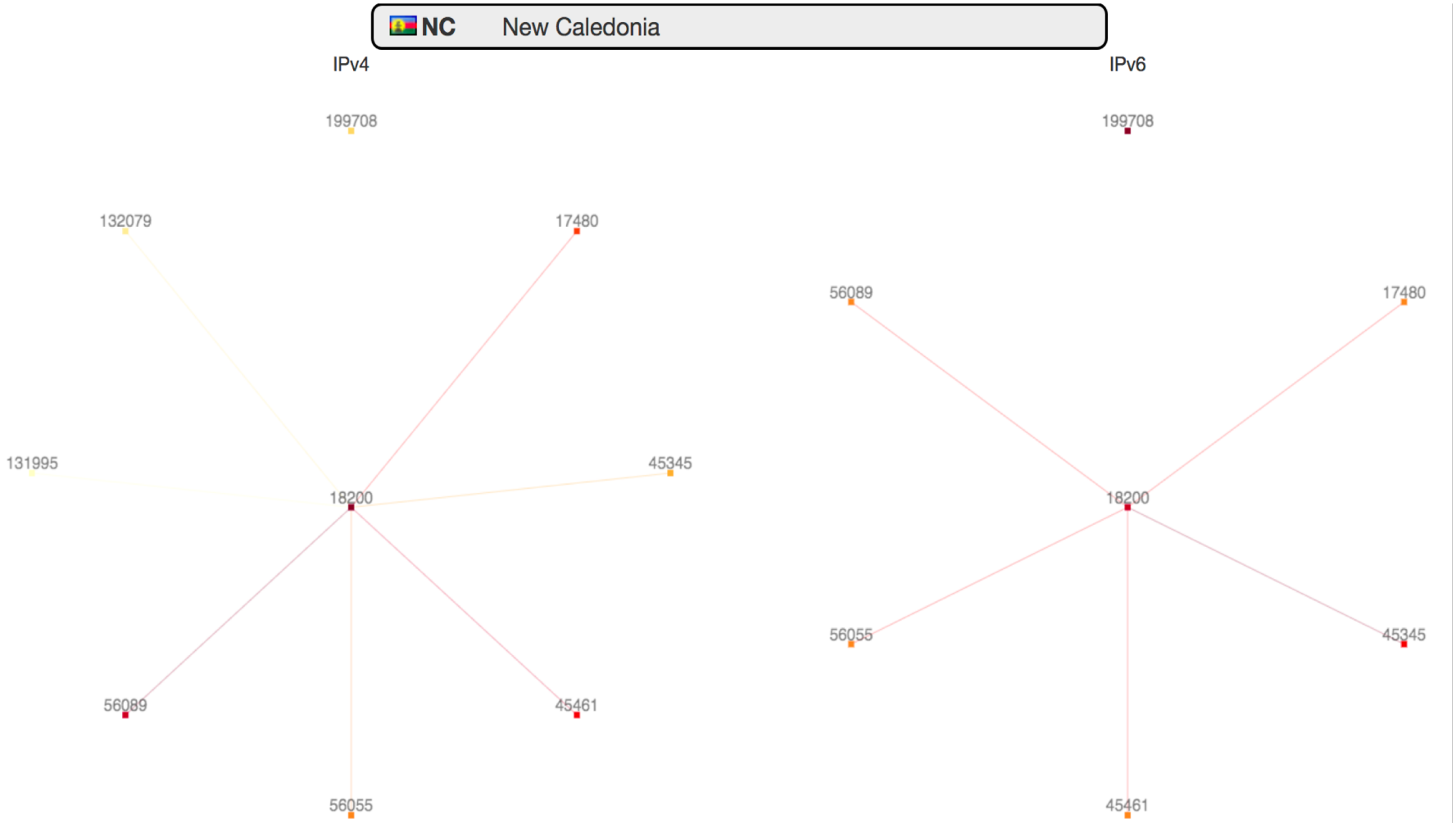
CC	Country	IPv6 Capable	IPv6 Preferred	Samples
NZ	New Zealand, Australia and New Zealand, Oceania	20.09%	17.10%	921,767
AU	Australia, Australia and New Zealand, Oceania	16.83%	15.91%	3,793,498
SB	Solomon Islands, Melanesia, Oceania	0.08%	0.01%	9,951
VU	Vanuatu, Melanesia, Oceania	0.03%	0.03%	6,053
PG	Papua New Guinea, Melanesia, Oceania	0.03%	0.00%	32,698
NC	New Caledonia, Melanesia, Oceania	0.01%	0.01%	20,373
AS	American Samoa, Polynesia, Oceania	0.01%	0.00%	10,165
MH	Marshall Islands, Micronesia, Oceania	0.01%	0.01%	14,152
FM	Micronesia (Federated States of), Micronesia, Oceania	0.01%	0.01%	17,919
PF	French Polynesia, Polynesia, Oceania	0.00%	0.00%	67,607
GU	Guam, Micronesia, Oceania	0.00%	0.00%	165,033
FJ	Fiji, Melanesia, Oceania	0.00%	0.00%	148,373
MP	Northern Mariana Islands, Micronesia, Oceania	0.00%	0.00%	16,272
NR	Nauru, Micronesia, Oceania	0.00%	0.00%	446
KI	Kiribati, Micronesia, Oceania	0.00%	0.00%	5,665
NU	Niue, Polynesia, Oceania	0.00%	0.00%	216
NF	Norfolk Island, Australia and New Zealand, Oceania	0.00%	0.00%	682
TO	Tonga, Polynesia, Oceania	0.00%	0.00%	4,494
CK	Cook Islands, Polynesia, Oceania	0.00%	0.00%	2,587
WS	Samoa, Polynesia, Oceania	0.00%	0.00%	1,493
PW	Palau, Micronesia, Oceania	0.00%	0.00%	6,082
TV	Tuvalu, Polynesia, Oceania	0.00%	0.00%	259
WF	Wallis and Futuna Islands, Polynesia, Oceania	0.00%	0.00%	779
TK	Tokelau, Polynesia, Oceania	0	0	1

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

IPv6 capability – New Caledonia

ASN	AS Name	IPv6 Capable	IPv6 Preferred	Samples
AS56089	OFFRATEL-AS-AP OFFRATEL	0.01%	0.01%	6,692
AS17480	CANL CANL	0.03%	0.03%	3,879
AS18200	OPT-NC-AS-AP Office des Postes et Telecommunications New-Caledonia	0.00%	0.00%	3,662
AS56055	MLS-NC Micro Logic Systems	0.00%	0.00%	3,300
AS45345	NAUTILE-NC-AS-AP Nautile	0.04%	0.04%	2,417
AS45461	TELENET-AS-AP TeleNet	0.00%	0.00%	423

IPv6 interconnections - NC



https://labs.apnic.net/vizas/index.html#NC

IPv6 Performance

- Is IPv6 inferior to IPv4 in terms of service performance?

  - Two sessions between the same endpoints
  - Same e2e transport protocol
  - Same applications at each end
  - Different IP protocol used by the two sessions

IPv6 Performance

- Enough data collected to analyze IPv6 performance
  - APNIC Labs

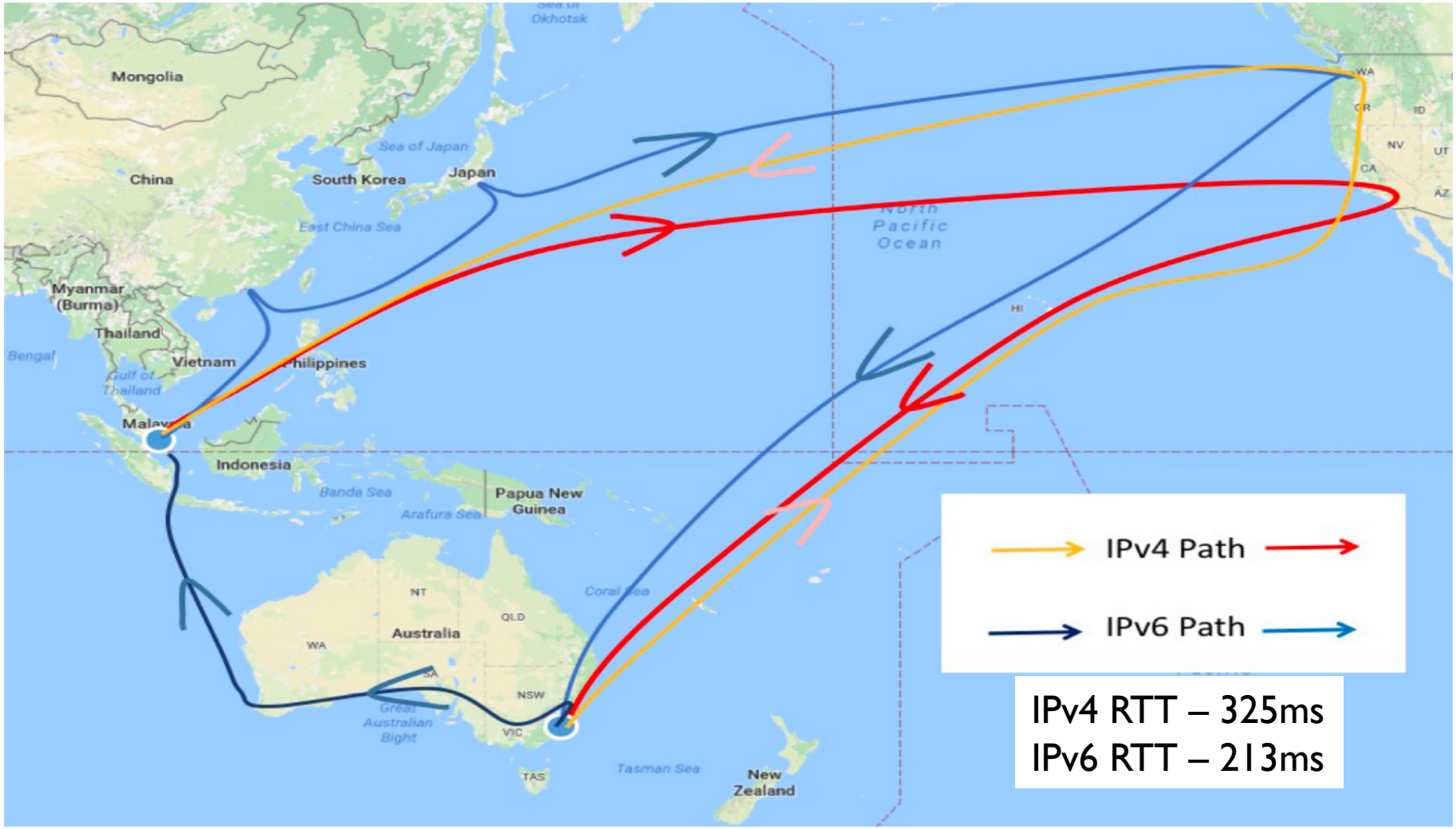
- **Is IPv6 as robust as IPv4**?
  - Do all TCP connection attempts succeed?
    - *Connection failure = no ACK for an acknowledged SYN*
  - IPv4 connection failure sits at 0.2%
  - IPv6 connection failure sits at 1.6% (8 times higher!)
    - PMTUD (ICMPv6 filters)?

IPv6 Performance

- Enough data collected to analyze IPv6 performance
  - APNIC Labs

- **Is IPv6 as fast as IPv4**? (IPv6 unicast)
  - Comparison of RTT (not implicit RTT)
    - *Time since SYN till ACK*
    - factors out any congestion issues
  - IPv6 is faster about half of the time
    - **45**ms faster (world average)
    - NAT?
    - IPv4 and IPv6 using different paths (different peering policies for IPv4 and IPv6)?
  - **IPv6 as fast as IPv4**

Routing path & performance



https://labs.apnic.net/?p=850

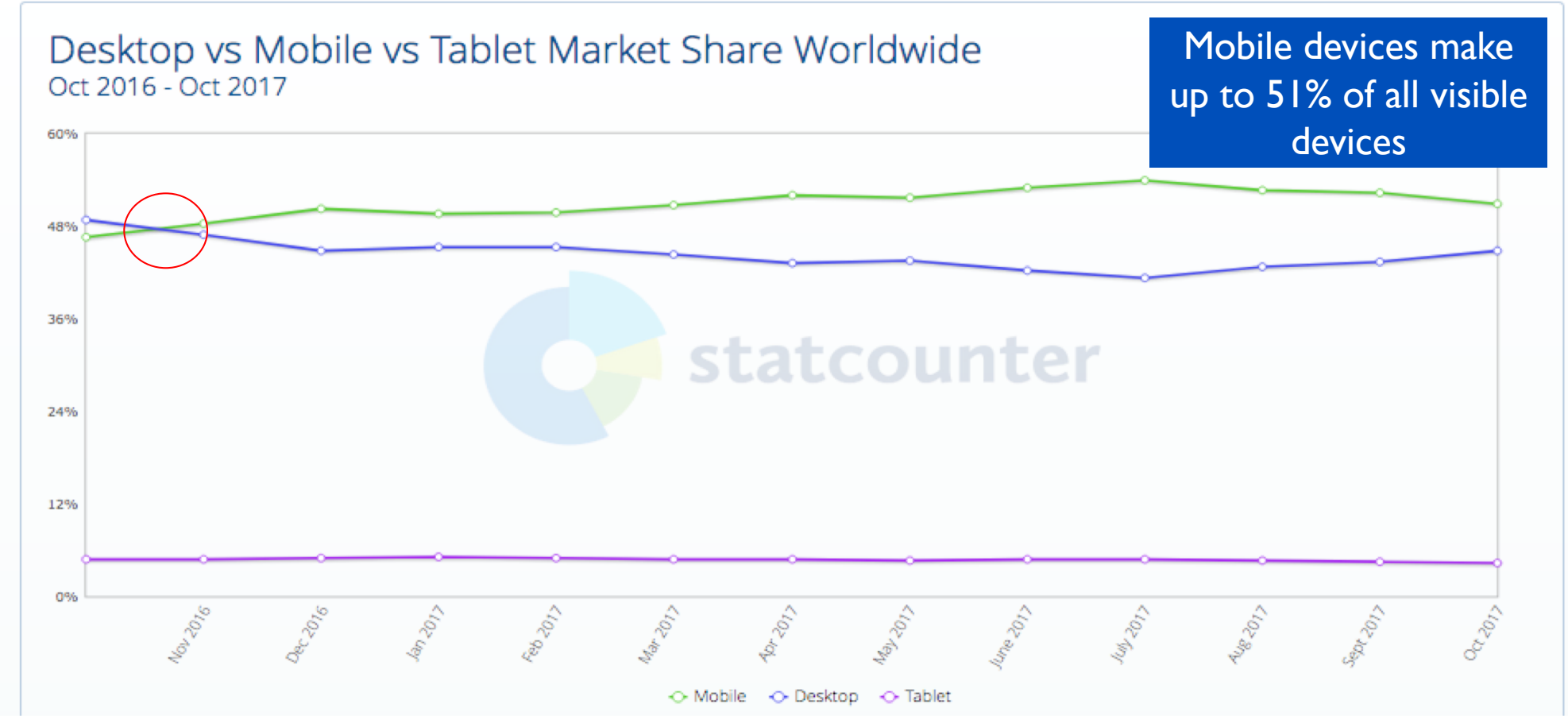
IPv6 Performance

- Some good use cases
- LinkedIn Senior Director of Infrastructure Engineering, Zaid Ali Kahn
  - @APNIC42 (September 2016)

- **IPv6 at LinkedIn:**
  - For some select networks in **Europe**, LinkedIn is seeing up to **40%** performance improvements over IPv6, and in the **US**, up to **10%**
  - TCP timeout on **IPv4** over mobile carrier networks is as high as **4.6%** and **IPv6** timeouts are on a much lower side at **1.6%**
    - CG-NAT configuration (TCP translation timeouts)?

https://blog.apnic.net/2016/05/13/linkedin-ipv6-measurements/

Industry trend: Who is in control?



http://gs.statcounter.com/platform-market-share/desktop-mobile-tablet

Industry trend: Who is in control?

- Mobile is driving the internet
- However, born and raised on NAT!
  - Still heavily based on CG-NAT (NAT44)
- **The true driver for IPv6 adoption is mobile internet!**

IPv6 in Mobile Networks: Technology

Carrier	Economy	Deployment
Reliance Jio	India	Dual stack in 2016
SK Telecom	Korea	464XLAT in 2014
Telstra	Australia	464XLAT since 2016
T-Mobile	USA	464XLAT in 2012
Verizon Wireless	USA	Dual stack in 2011

Dual-stack in mobile network

- Does ***not solve IPv4 (public) depletion*** issue
  - Still need to use CG-NAT to access IPv4-only sites

- But ***effective***, and the only viable and scalable way forward
  - IPv6 native access to most of the major content providers
  - None of the scalability issues of v4 CG-NAT
  - And of course, *no DNSSEC* issues

IPv6 and Mobile devices

- Android: supports 464XLAT (**4.4 - KitKat**)
- iOS: IPv6 supported over mobile interface since iOS 9 (*supported IPv6 on WiFi for a long time!)*
  - All apps submitted to App Store must support IPv6 (only) since June 2016
    - https://developer.apple.com/support/ipv6/

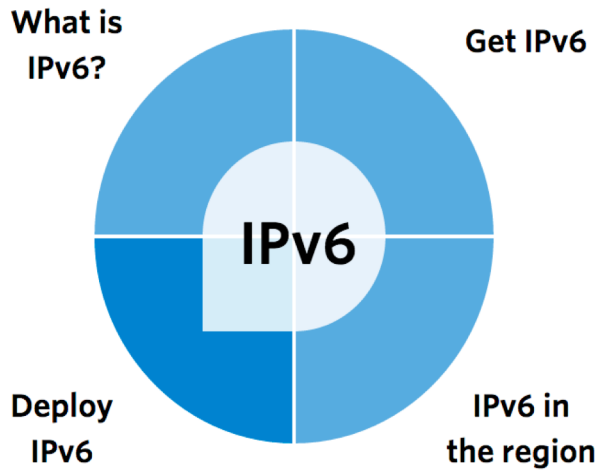
IPv6 Tethering

- **RFC6653**:DHCPv6-PD for Mobile Networks
  - 3GPP Release10

- **RFC7278**: Extending IPv6 prefix (`/64`) from Mobile interface to LAN
  - "Flaky" support since Android **6.0** (***Marshmallow***)
  - Stop-gap until DHCPv6-PD

www.apnic.net/ipv6

Deploy IPv6



Deploying IPv6 can be a challenge but many organizations around the world have made the transition successfully. Here's some of the elements you'll need to consider for your organization's deployment of IPv6.

10-Step Plan | Transition Technologies | Success Stories | Helpful Resources | Training

Thank You!

END OF SESSION