

Where are we now?

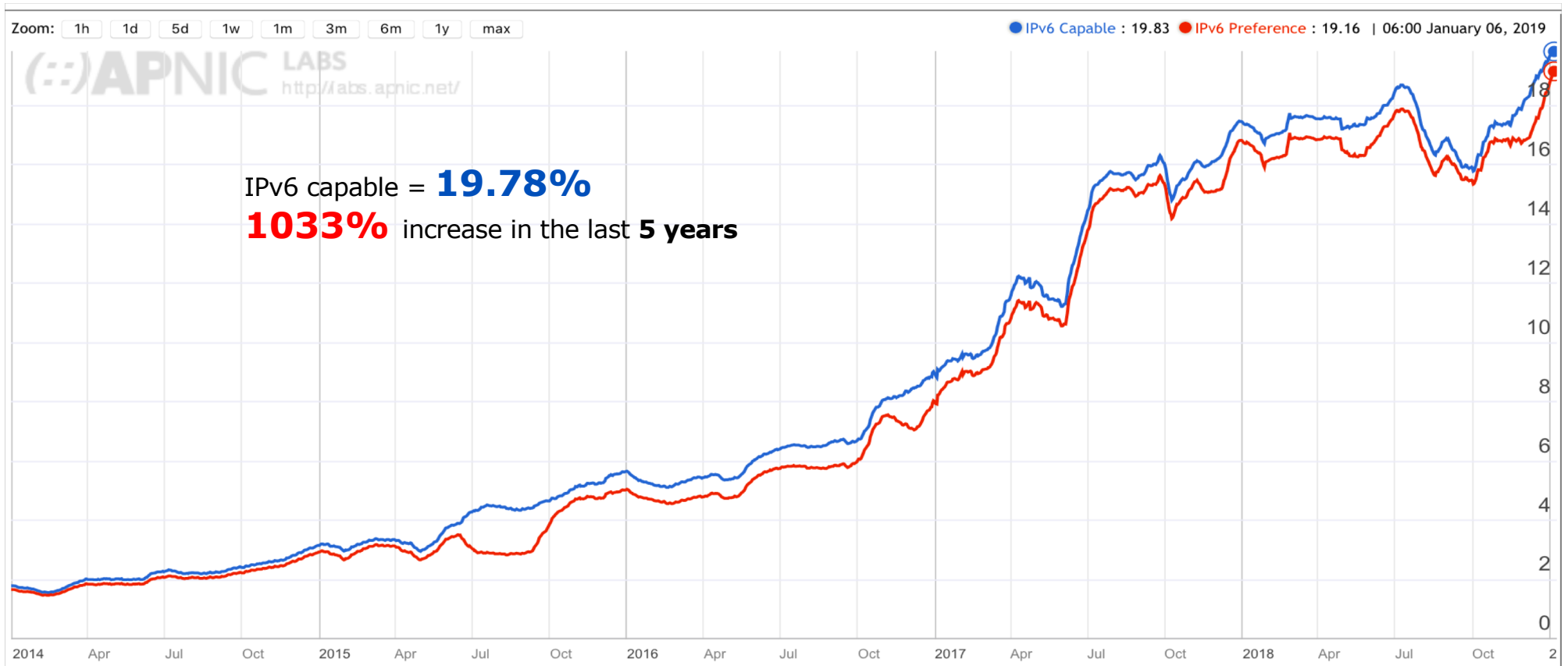
[IPv6 deployment update]

SANOG33 | 11 Jan 2019 | Thimphu - Bhutan

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IPv6 End-User Readiness



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

IPv6 table - World

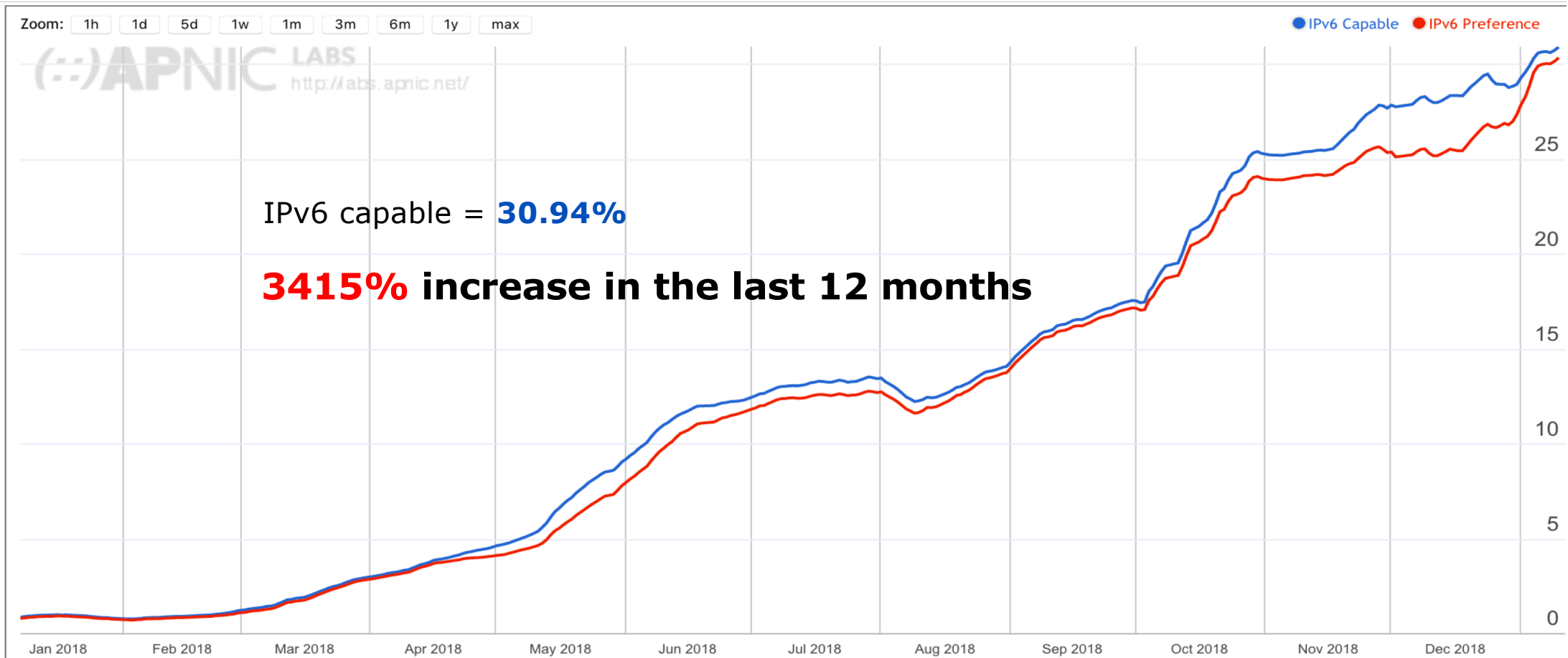
Economy	IPv6 capable (%)
India	56.93
Belgium	55.54
United States	47.46
Germany	39.56
Greece	34.13
Malaysia	33.67
Taiwan	30.70
Finland	29.22
United Kingdom	28.08
Japan	27.95
Uruguay	27.83
Brazil	27.74
Luxembourg	27.00

Economy	IPv6 capable (%)
Switzerland	26.67
Vietnam	26.37
Thailand	24.03
Estonia	23.59
Canada	23.36
Mexico	22.50
Trinidad & Tobago	22.20
Aland Islands	22.13
France	22.03
New Zealand	20.66
Hungary	19.28
Sint Maarten	17.72
Ireland	17.08
Portugal	16.26
Peru	16.16

What about Asia-Pacific?

CC	Economy	IPv6 capable (%)
IN	India	56.67
TW	Taiwan	30.94
MY	Malaysia	33.73
JP	Japan	27.98
VN	Vietnam	26.34
TH	Thailand	23.95
NZ	New Zealand	20.63
AU	Australia	13.40
LK	Sri Lanka	11.28
KR	Korea	9.56
SG	Singapore	9.29
CN	China	6.89

Taiwan Focus



AS 17421: EMOME

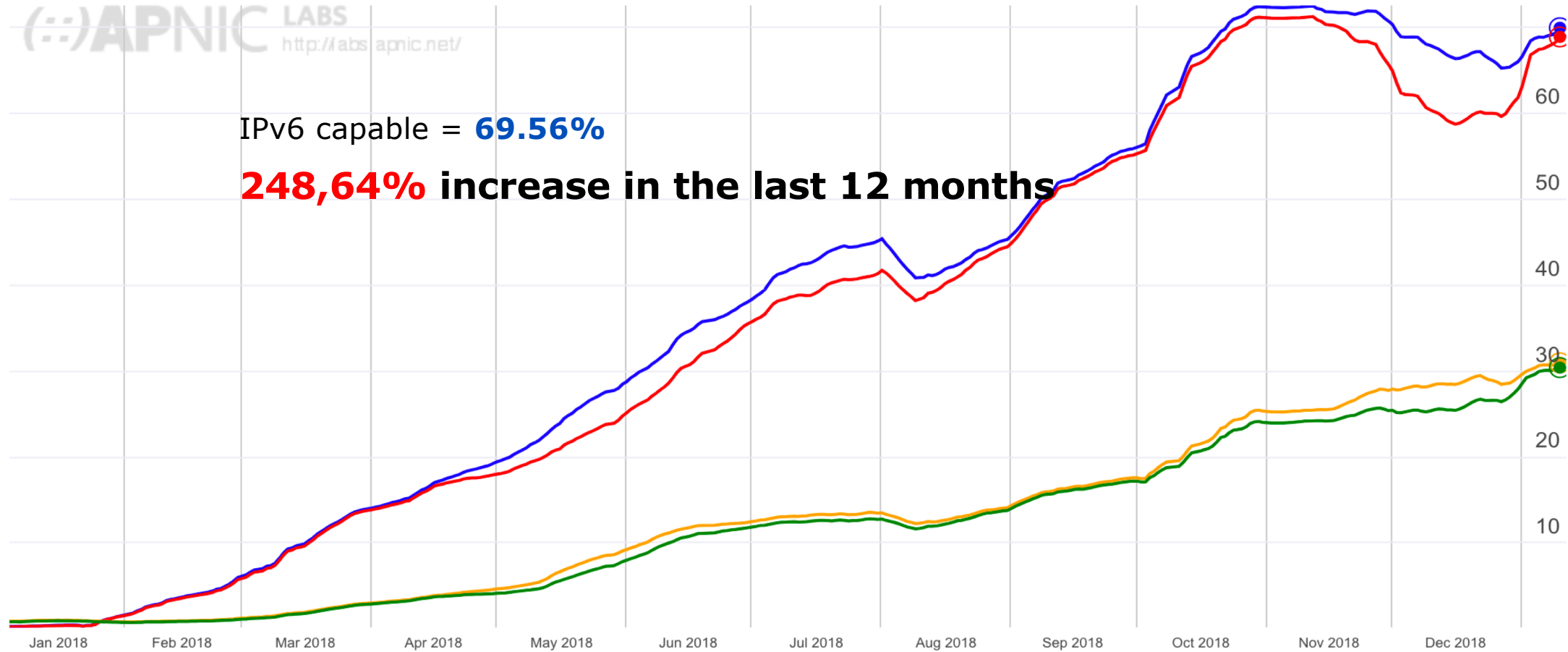
Zoom: 1h 1d 5d 1w 1m 3m 6m 1y max

AS IPv6 Capable : 69.9 AS IPv6 Preferred : 68.84 CC IPv6 Capable : 30.94 CC IPv6 Preferred : 30.38 | 06:00 January 10, 2019

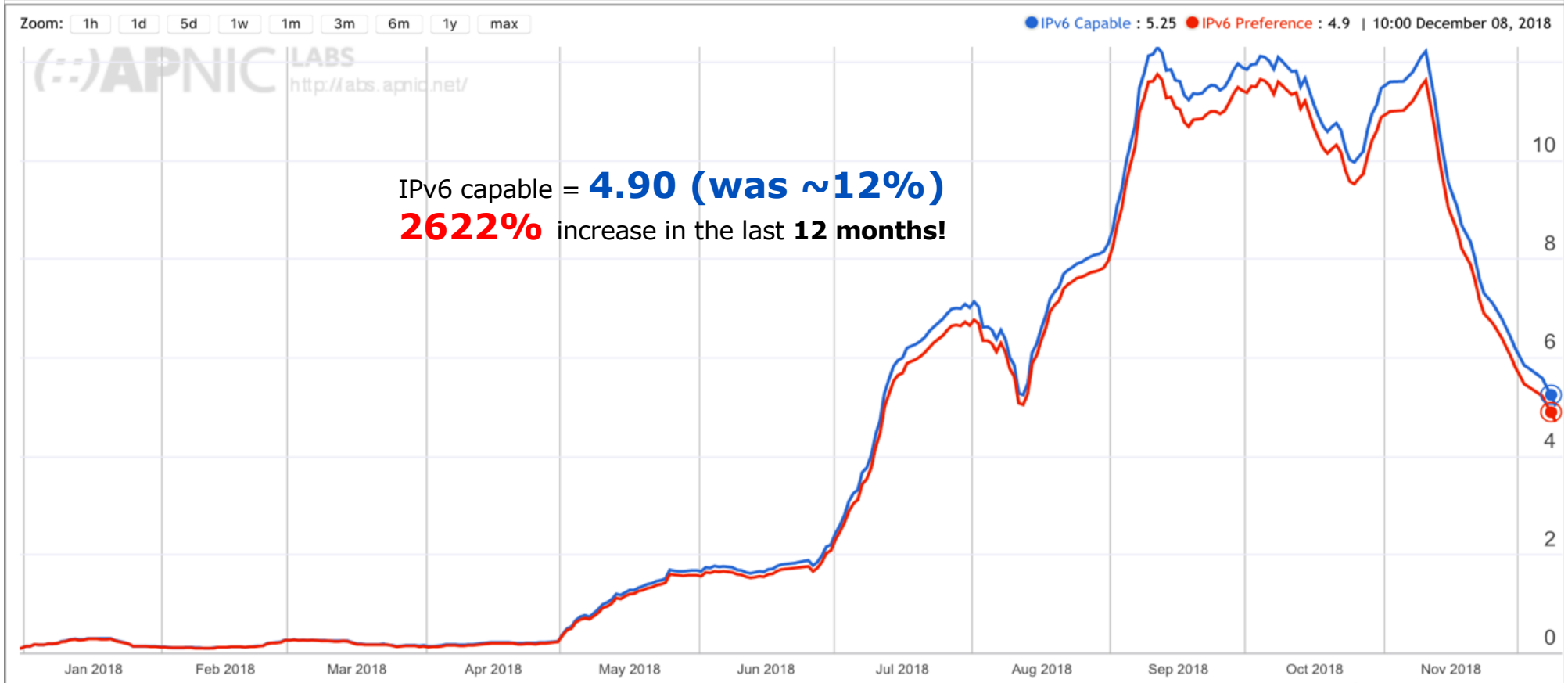
APNIC LABS
<http://labs.apnic.net/>

IPv6 capable = **69.56%**

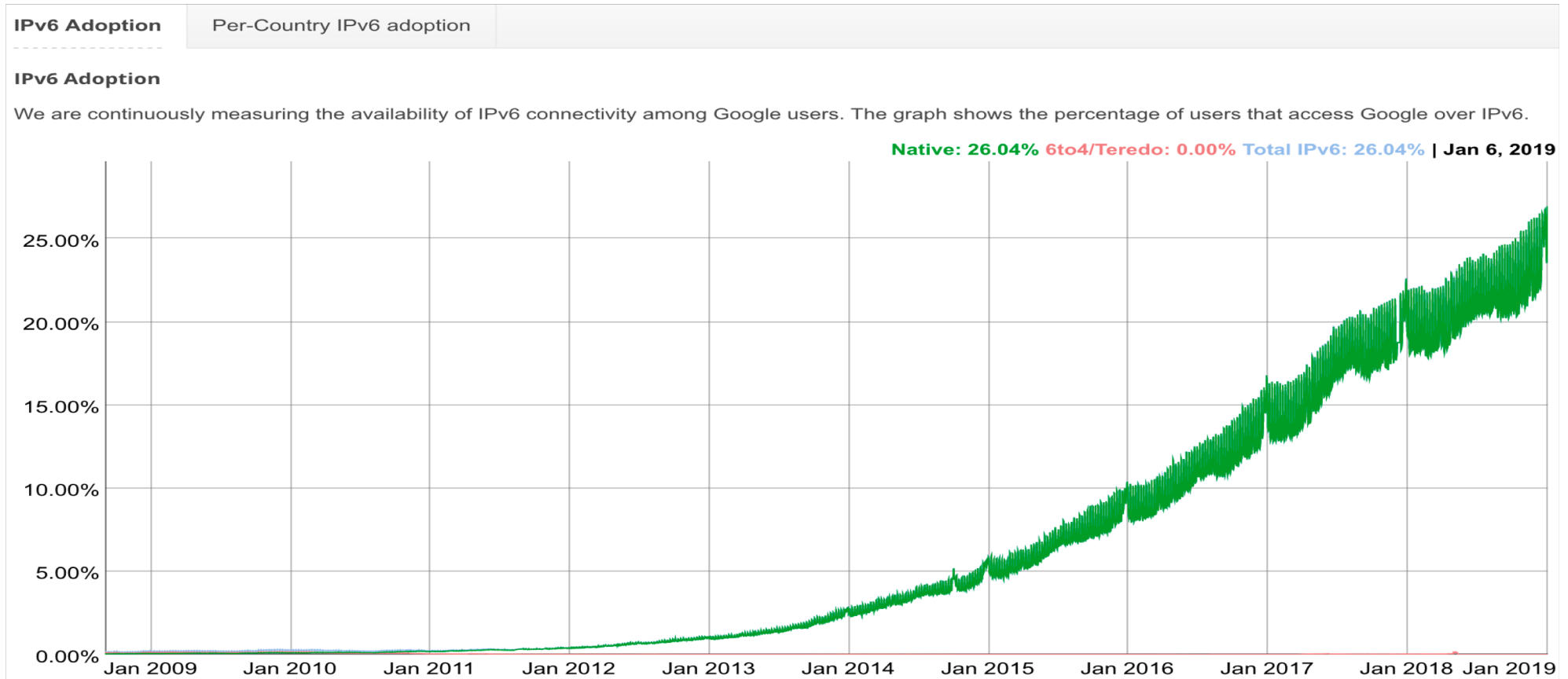
248,64% increase in the last 12 months



What about Bhutan?

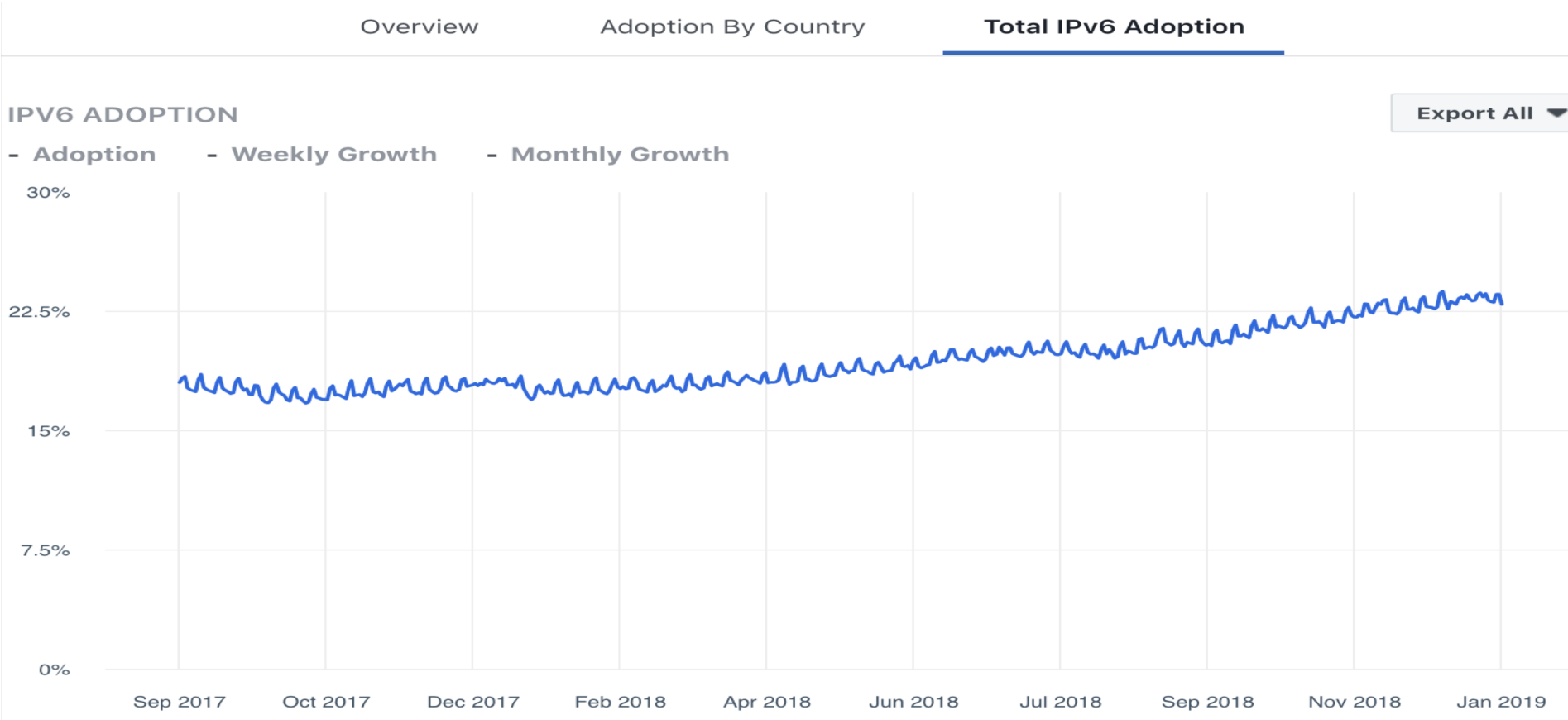


IPv6 in action - Google



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

IPv6 in action - Facebook



<https://www.facebook.com/ipv6/>

IPv6 Performance

Enough data collected to analyze IPv6 performance
– APNIC Labs

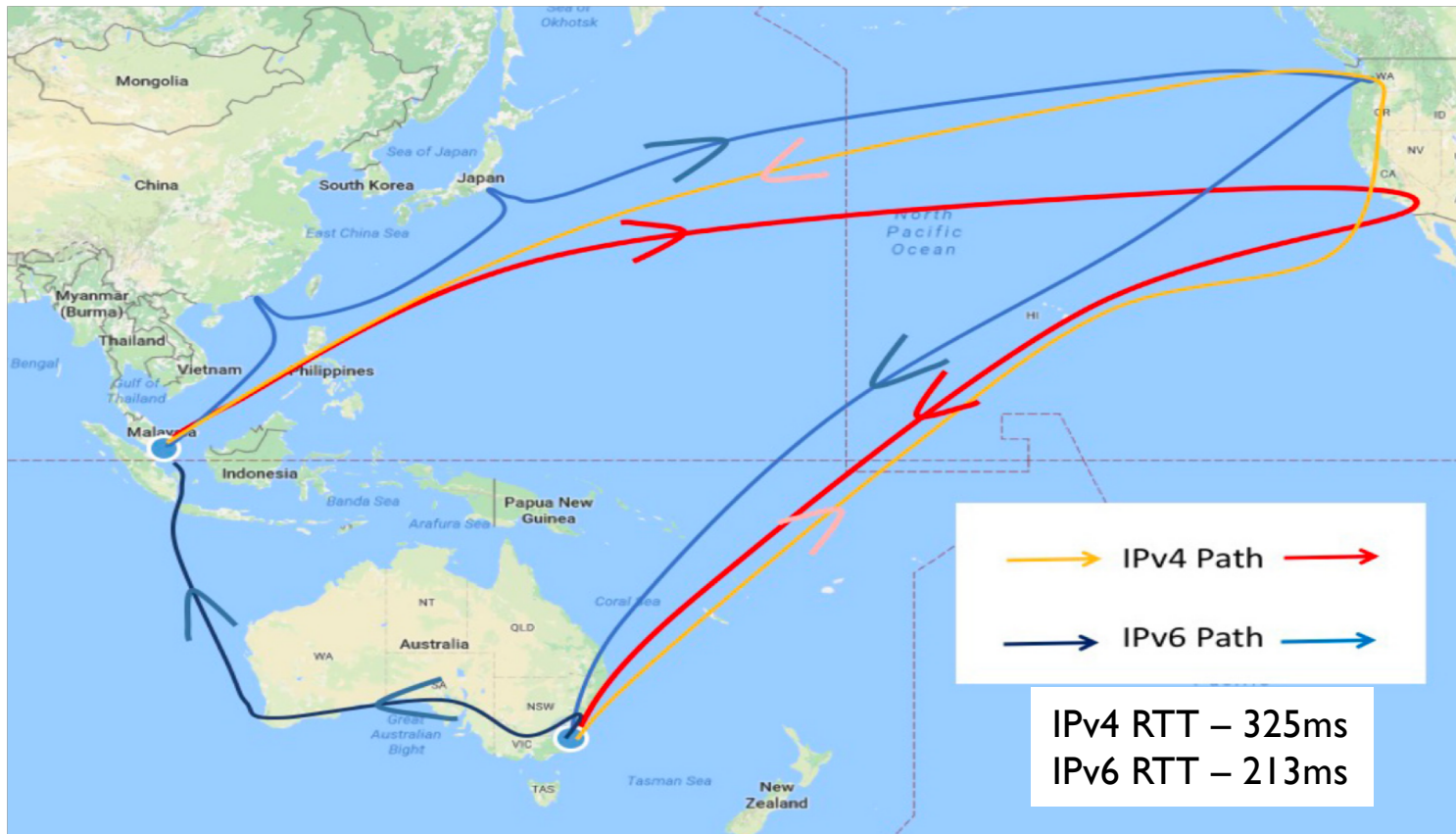
- **Is IPv6 as **robust** as IPv4?**
 - Do all TCP connection attempts succeed?
 - *Connection failure = no ACK for an SYN*
 - IPv4 connection failure sits at 0.2%
 - IPv6 connection failure sits at 1.6% (8 times higher!)
 - PMTUD (ICMPv6 filters)?

IPv6 Performance

- **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
 - **45ms** faster (36-90ms)... **66ms** in BT
 - NAT?
 - IPv4 and IPv6 using different paths (different peering policies for IPv4 and IPv6)?
 - **TechArk** measured **IPv6 performance for HTTP traffic**
 - IPv6 performance better when measuring nearer targets!

<https://blog.apnic.net/2017/09/29/network-operator-perspective-ipv6-performance/>

Routing path & performance

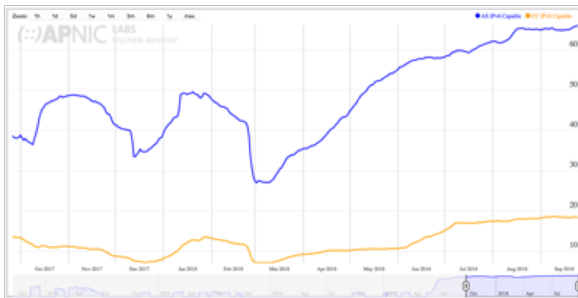


<https://labs.apnic.net/?p=850>

Three-stages of IPv6 Growth

Fast growth driven by single, early market driver

- *Incl. Australia, Bhutan, South Korea, Taiwan*

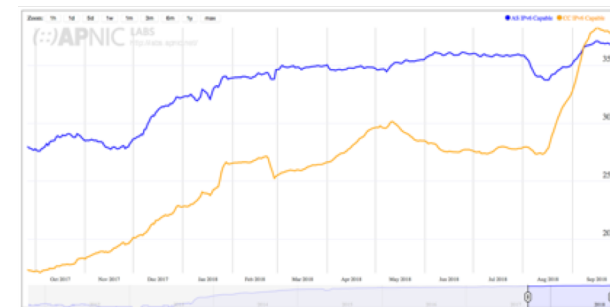


Initial roll-out followed by spread to other Internet Service Providers

- *Incl. India, Sri Lanka, Thailand, Viet Nam*

Mature IPv6 market with rich availability from access providers and deployment by providers of Internet services (incl. content, cable TV, cloud)

- *Incl. Japan, Malaysia, Singapore*



Motivation for Early Market Drivers

- Simplify network design
- Commitment to Internet Tech Evolution
- Government Encouragement
- Capability to support growth, IoT, Smart Cities, future services
- Reduce load on CGN
- Lower CAPEX

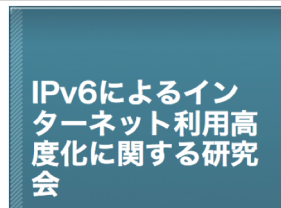
Network Working Group
Request for Comments: 2460
Obsoletes: 1883
Category: Standards Track

S. Deering
Cisco
R. Hinden
Nokia
December 1998

Internet Protocol, Version 6 (IPv6)
Specification

Status of this Memo

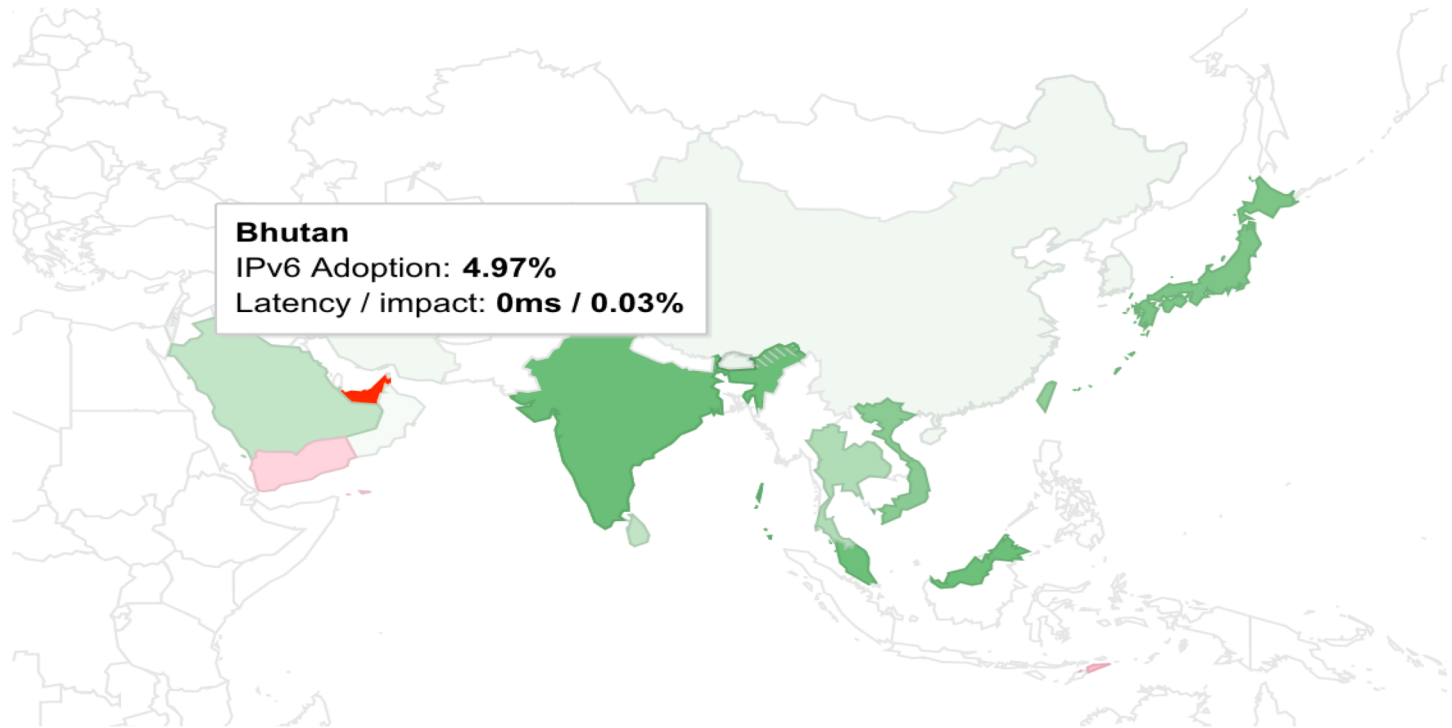
This document specifies an Internet standards track protocol for the Internet community, and requests discussion and suggestions for improvements. Please refer to the current edition of the "Internet Official Protocol Standards" (STD 1) for the standardization state and status of this protocol. Distribution of this memo is unlimited.



ADVISORY GUIDELINES
ADOPTION OF IPv6 IN BRUNEI DARUSSALAM

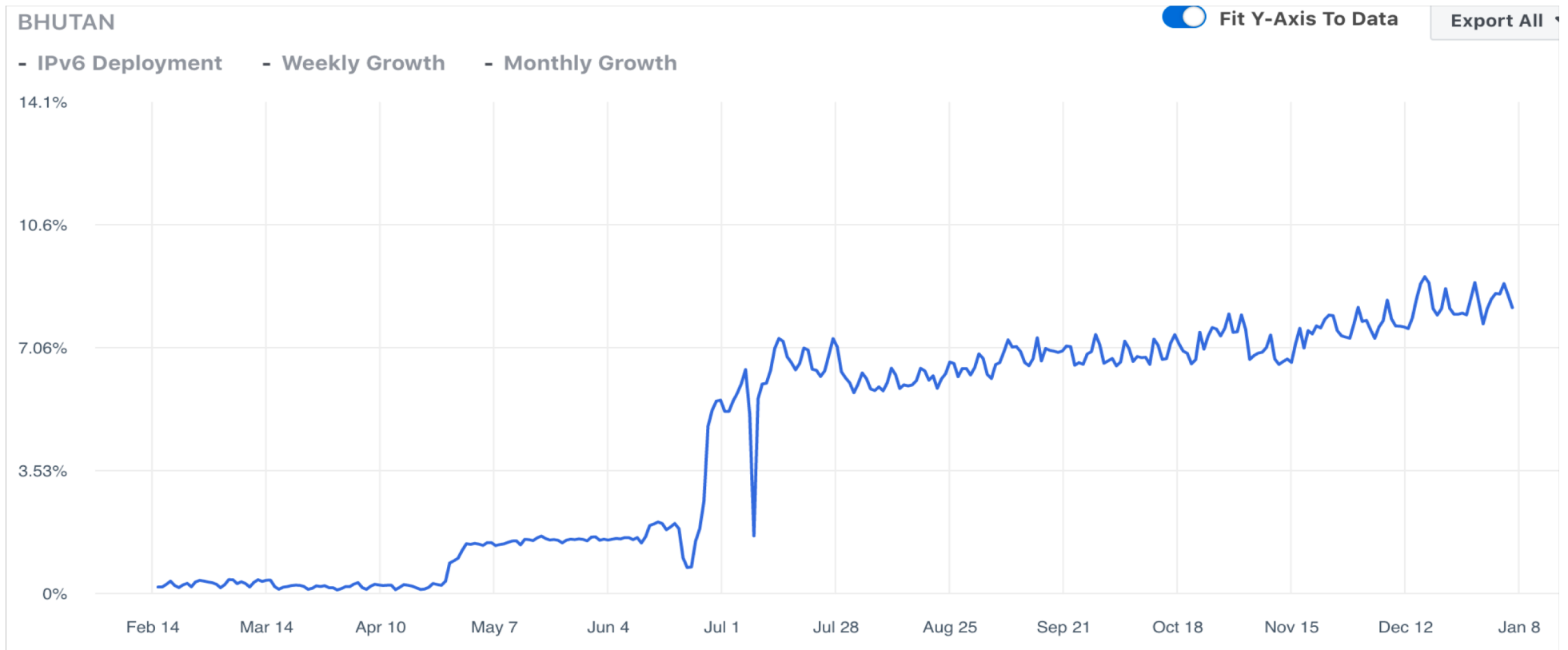
What about Bhutan?

Per-Country IPv6 adoption



<https://www.google.com/intl/en/ipv6/statistics.html#tab=per-country-ipv6-adoption>

What about Bhutan?



https://www.facebook.com/ipv6/?tab=ipv6_country

Industry trend: Who is in control?

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

IPv6 in Action: Mobile Networks

Carrier	Economy	Deployment
Verizon Wireless	USA	Dual-stack (2011)
T-Mobile	USA	464XLAT (2012)
SK Telecom	Korea	464XLAT (2014)
Telstra	Australia	464XLAT (2016)
Reliance Jio	India	Dual-stack (2016)
AIS	Thailand	Dual-stack (2016 – wired, 2017 – Mobile)
Bhutan Telecom	Bhutan	Dual-stack (2018)
Chungwa Telecom	Taiwan	Dual-stack (2018)

IPv6 and Mobile devices

- 464XLAT:
 - Android (**4.4 - KitKat**)
 - Windows Phone (**8.1+**)
- IPv6-only:
 - iOS
 - since iOS 9 (*supported Ion WiFi for a long time*)
 - since June 2016, apps in App Store must support IPv6 <https://developer.apple.com/support/ipv6/>
- DHCPv6:
 - Windows
 - iOS
- Dual-stack:
 - KaiOS (Jio handsets)
 - iOS: reports for dual-stack since 11.3 (through carrier update)

Where are we now?

"IPv6 has emerged from the 'Innovators' and 'Early Adoption' stages of deployment, and is now in the 'Early Majority phase'"

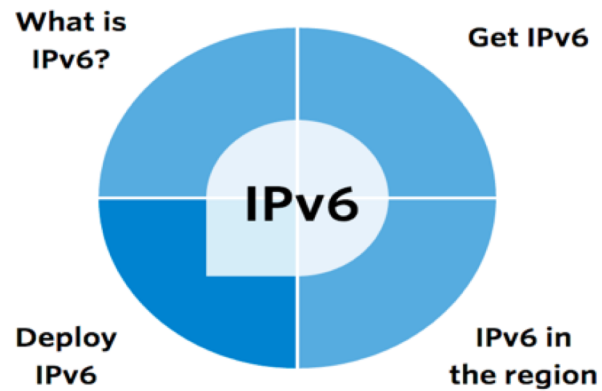
– ISOC State of IPv6 Deployment (2018)

- Global IPv6 end-user readiness is **19.78%**
 - **61.42%** of network operators in the Asia-Pacific have IPv6 resources.
- IPv6 end-user readiness is increasing (across diverse economy profiles).
- Common trend sees three stages of economy readiness.
- Mobile driven growth of IPv6 deployment
- Observed preference for dual-stack transition technology in recent deployments (PDP licensing?)
- Positive signs for future readiness growth, especially as vendor support grows

Aside: IPv6 Capable vs Preferred

- Uses scripted online advertisement
 - Over **7-10M** measurements/day!!
- The Ad script fetches three URLs
 - IPv4 only URL, IPv6 only URL, Dual-stack URL
- If:
 - Fetches IPv6 URLs (*native/dual-stack*) over IPv6, device deemed **IPv6 capable**
 - Fetches the dual-stack URL over IPv6, its deemed to **prefer IPv6**
 - RFC8305 (happy eyeballs) bias?

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
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apnic.net/ipv6



Questions

