Where are we now?
IPv6 deployment update

22-24 October 2018 | Ulaanbaatar, MN

Klée Aiken

klee@apnic.net

APNIC

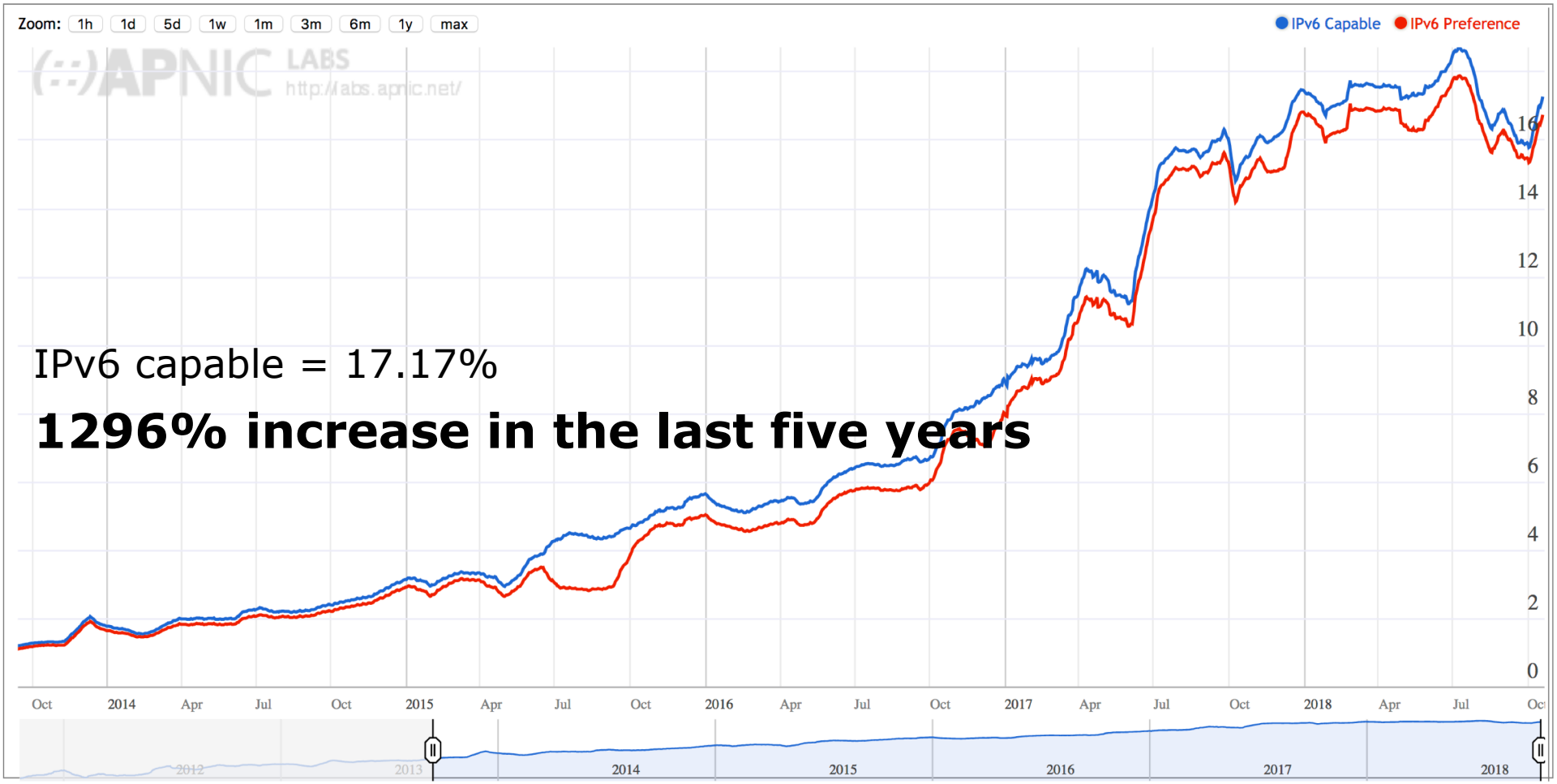
Agenda

- IPv6 End-User Readiness
- IPv6 Performance
- Industry Trends
- Observations

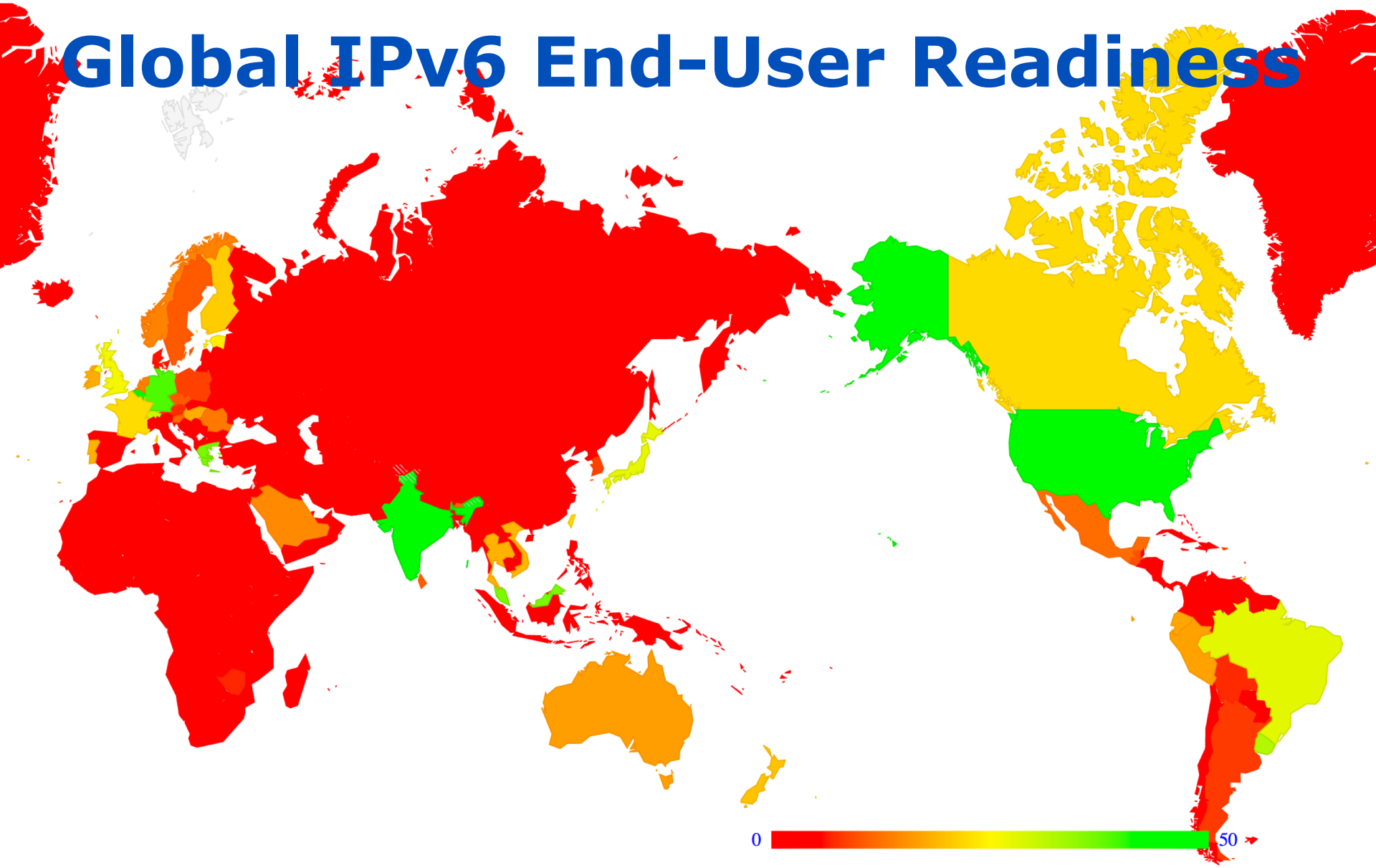
IPv6 stats from: https://stats.labs.apnic.net/ipv6
Retrieved: 18 Oct 2018

APNIC

Global IPv6 End-User Readiness



Global IPv6 End-User Readiness



The IPv6 economy league table

Economy	IPv6 capable (%)
Belgium	56.60
India	49.50
United States	45.57
Germany	39.17
Malaysia	36.56
Greece	36.18
Uruguay	31.54
Luxembourg	29.72
Switzerland	29.02
Brazil	27.79
Japan	26.89
United Kingdom	26.16
Estonia	24.07
Taiwan	22.90

Economy	IPv6 capable (%)
France	22.59
Canada	22.40
Trinidad & Tobago	21.72
Finland	21.22
New Zealand	19.80
Vietnam	19.35
Thailand	18.58
Portugal	18.43
Ireland	18.04
Hungary	17.93
Ecuador	17.38
Peru	17.10
Australia	16.30

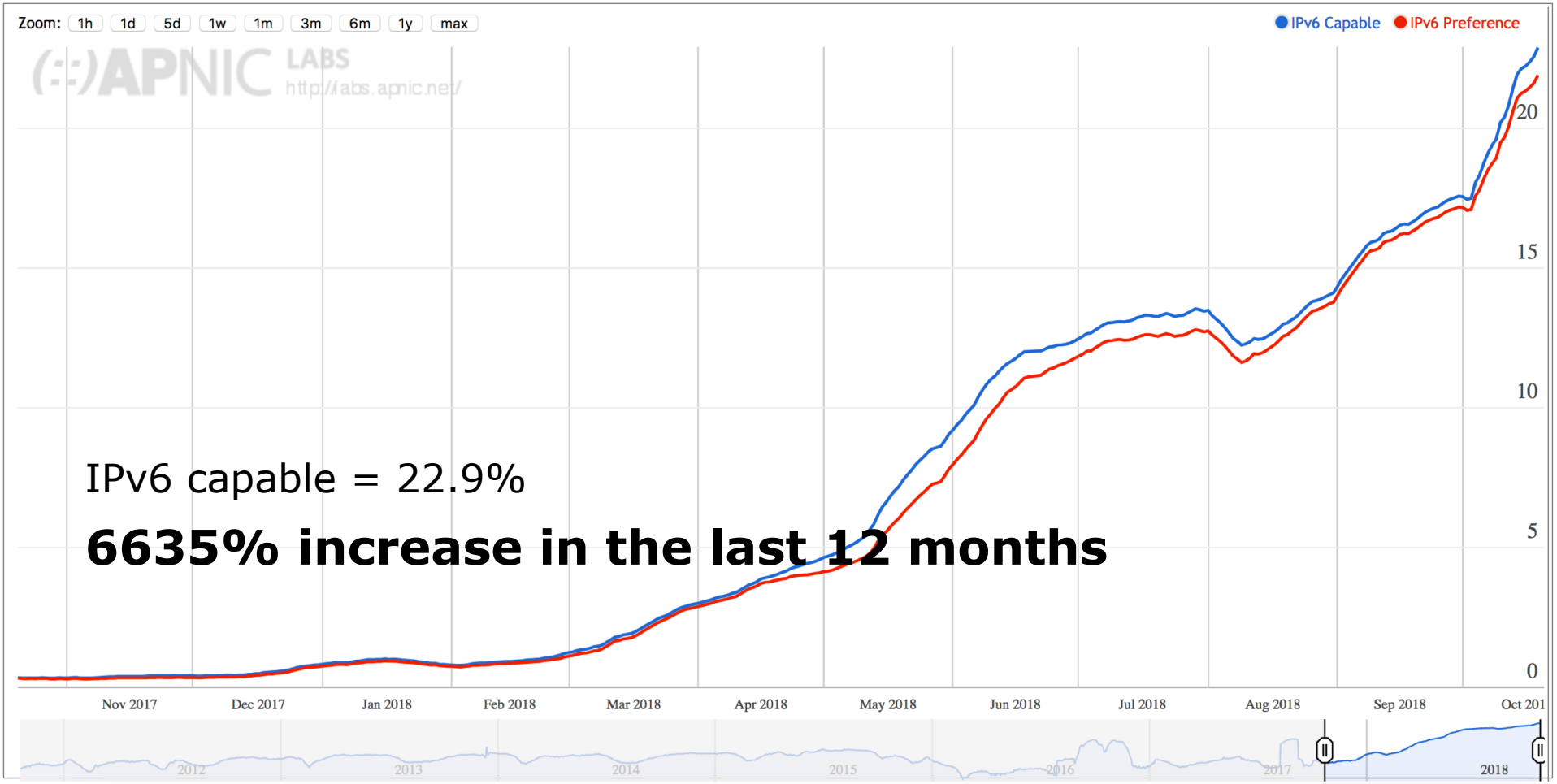
What about Asia-Pacific?

CC	Economy	IPv6 capable (%)
IN	India	49.50
MY	Malaysia	36.56
JP	Japan	26.89
TW	Taiwan	22.90
NZ	New Zealand	19.80
VN	Viet Nam	19.35
TH	Thailand	18.58
AU	Australia	16.30
LK	Sri Lanka	11.38
BT	Bhutan	10.84
SG	Singapore	8.90
KR	Korea	8.39

What about Asia-Pacific?

CC	Economy	IPv6 capable (%)
IN	India	49.50
MY	**Malaysia**	**36.56**
JP	Japan	26.89
TW	**Taiwan**	**22.90**
NZ	New Zealand	19.80
VN	Viet Nam	19.35
TH	**Thailand**	**18.58**
AU	Australia	16.30
LK	Sri Lanka	11.38
BT	Bhutan	10.84
SG	Singapore	8.90
KR	Korea	8.39

Taiwan IPv6 End-User Readiness



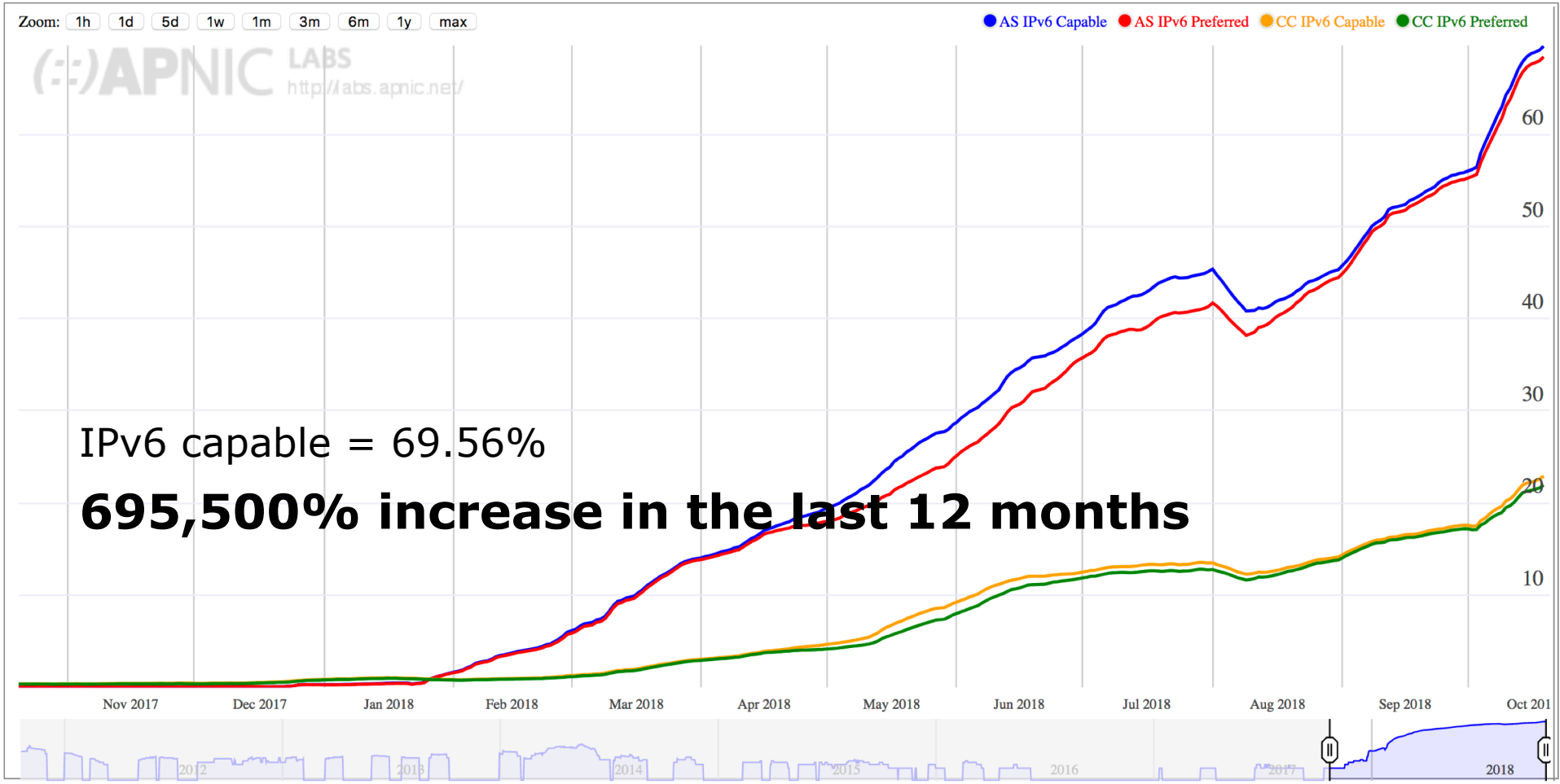
IPv6 capable = 22.9%

6635% increase in the last 12 months

Taiwan IPv6 leaderboard

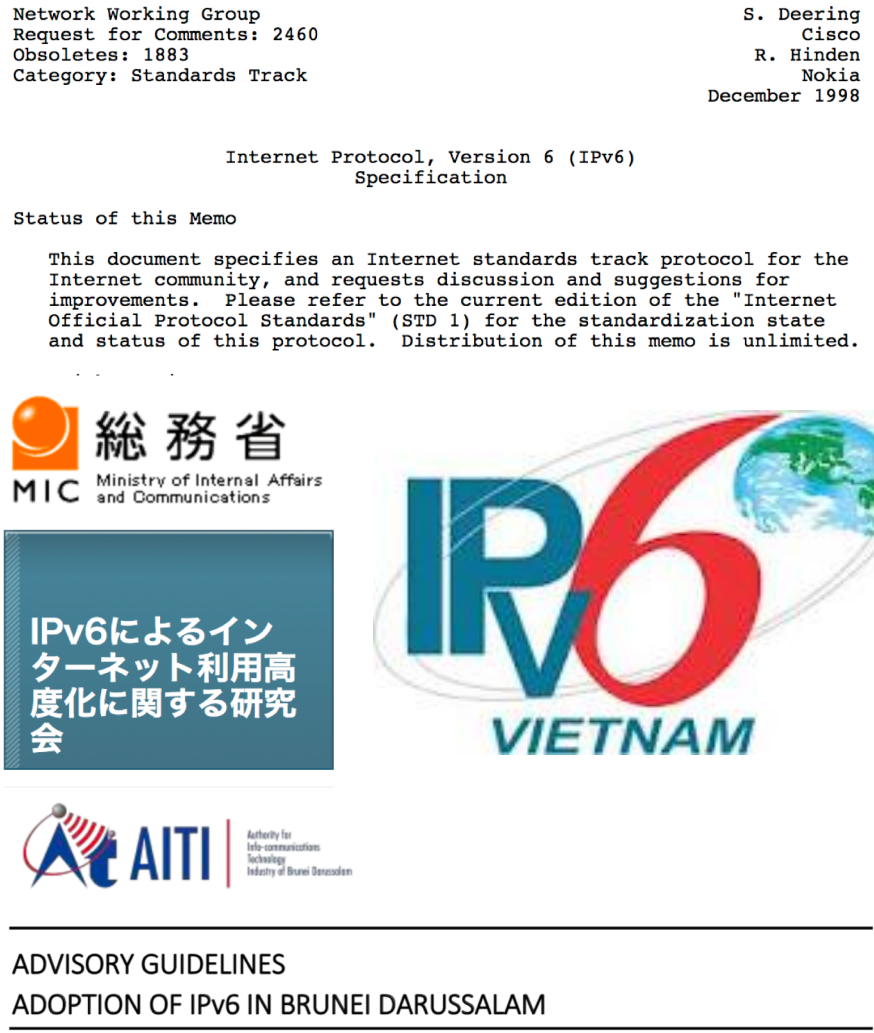
ASN	Organization	IPv6 capable (%)
17421	EMOME (Chunghwa Telecom)	69.56
3462	HINET (Chunghwa Telecom)	20.65
1659	TANet Information Center	18.32
24158	Taiwan Mobile	10.00
9674	Far EastTone	5.12
131591	Ambit Microsystem	2.27
4780	Seed Net	0.31
9416	Hoshin Multimedia Center	0.29
131596	Union Broadband	0.27
24164	Yeong Jia Leh Cable TV	0.23

AS 17421: EMOME



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.

総務省
MIC Ministry of Internal Affairs and Communications

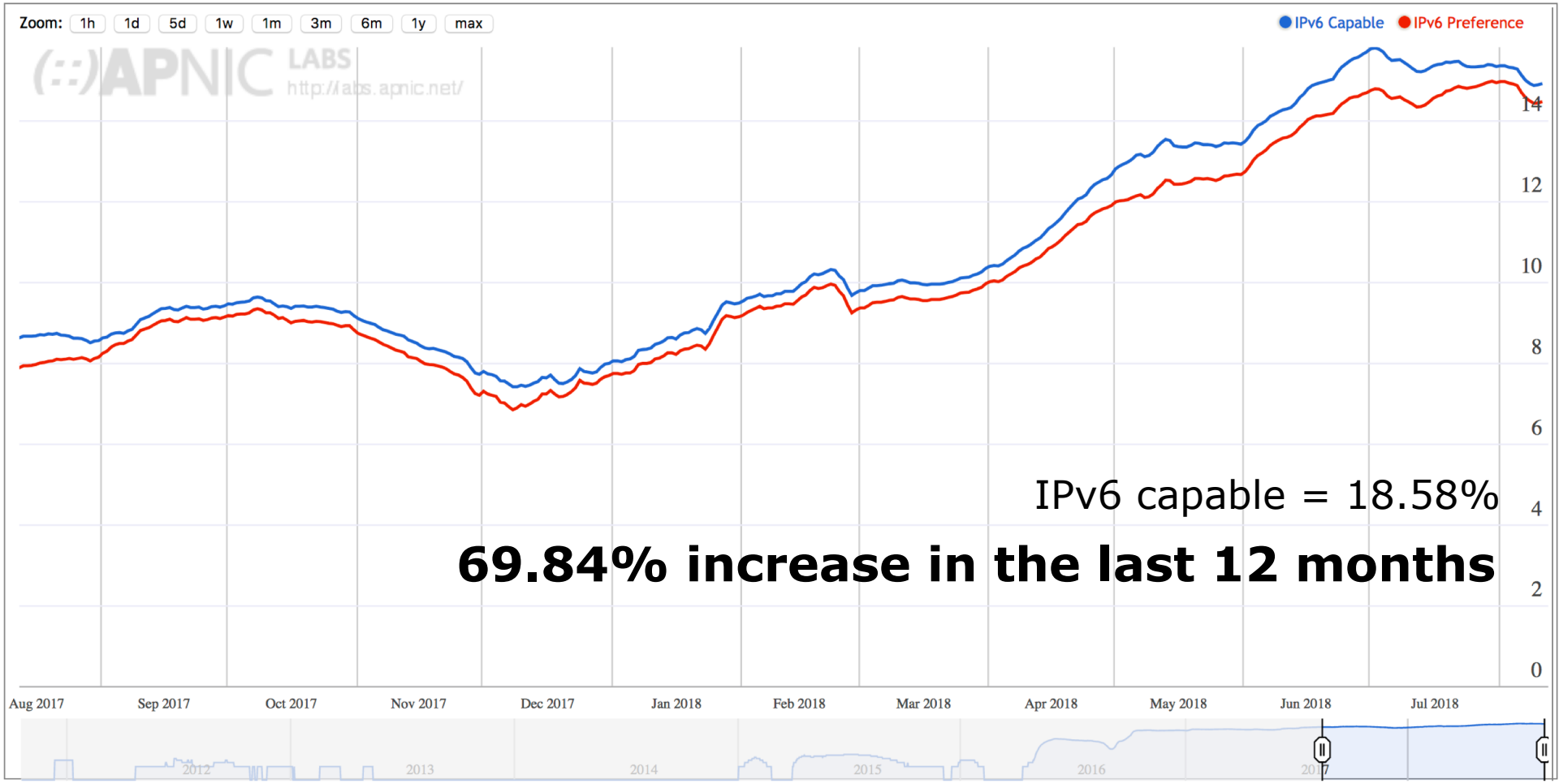
IPv6によるインターネット利用高度化に関する研究会

IPv6 VIETNAM

AITI

ADVISORY GUIDELINES
ADOPTION OF IPv6 IN BRUNEI DARUSSALAM

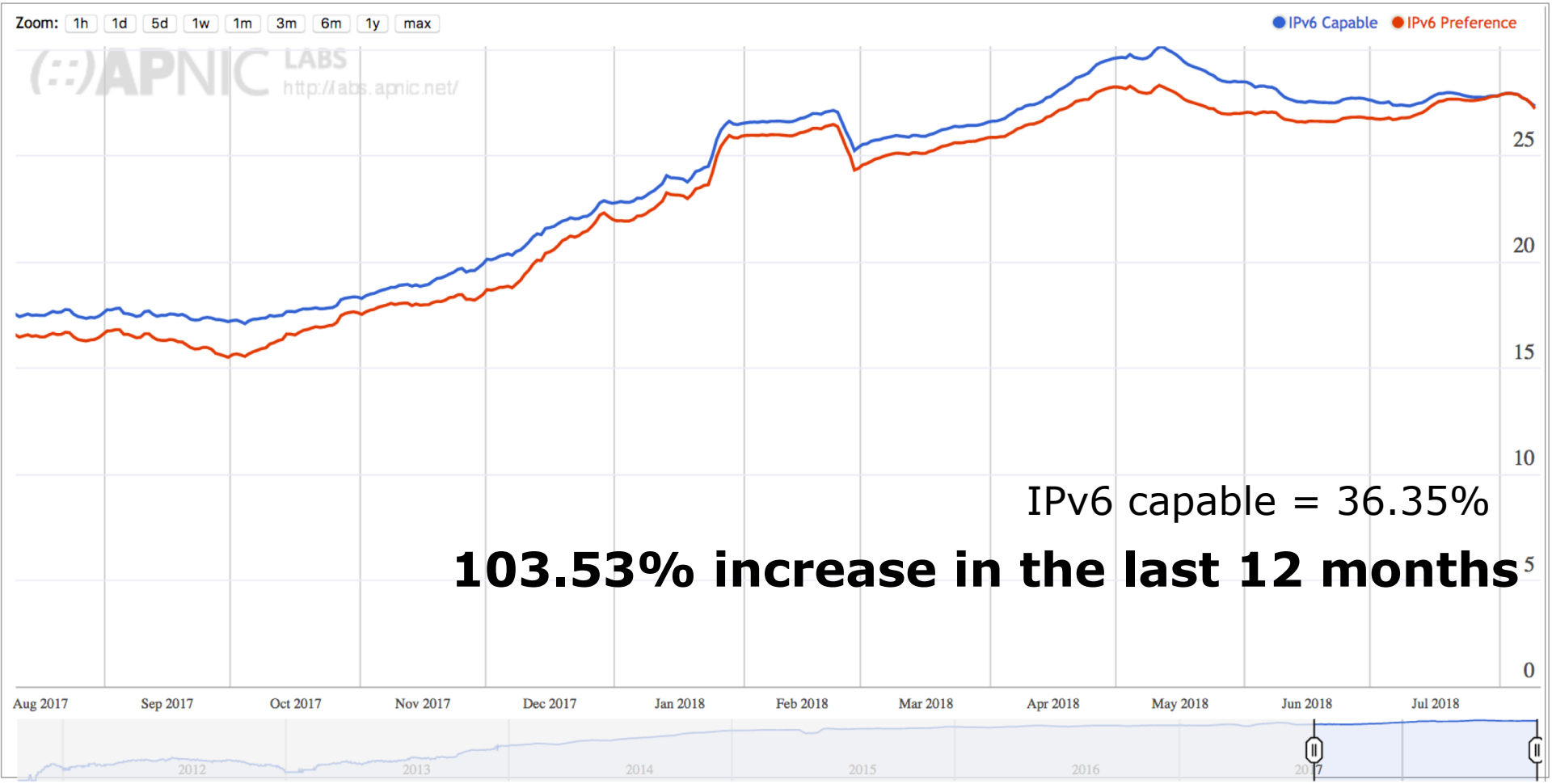
Thailand IPv6 End-User Readiness



Thailand IPv6 leaderboard

ASN	Organization	IPv6 capable (%)
131445	AIS 3G	70.31
133481	AIS Fibre	57.37
45629	JasTel	31.33
45758	Triple T	30.99
7470	True Internet	0.86
131090	CAT Telecom	0.18
17552	True Internet	0.15
23969	TOT Net	0.13
132061	Realmove Company	0.05
24378	Total Access	0.05

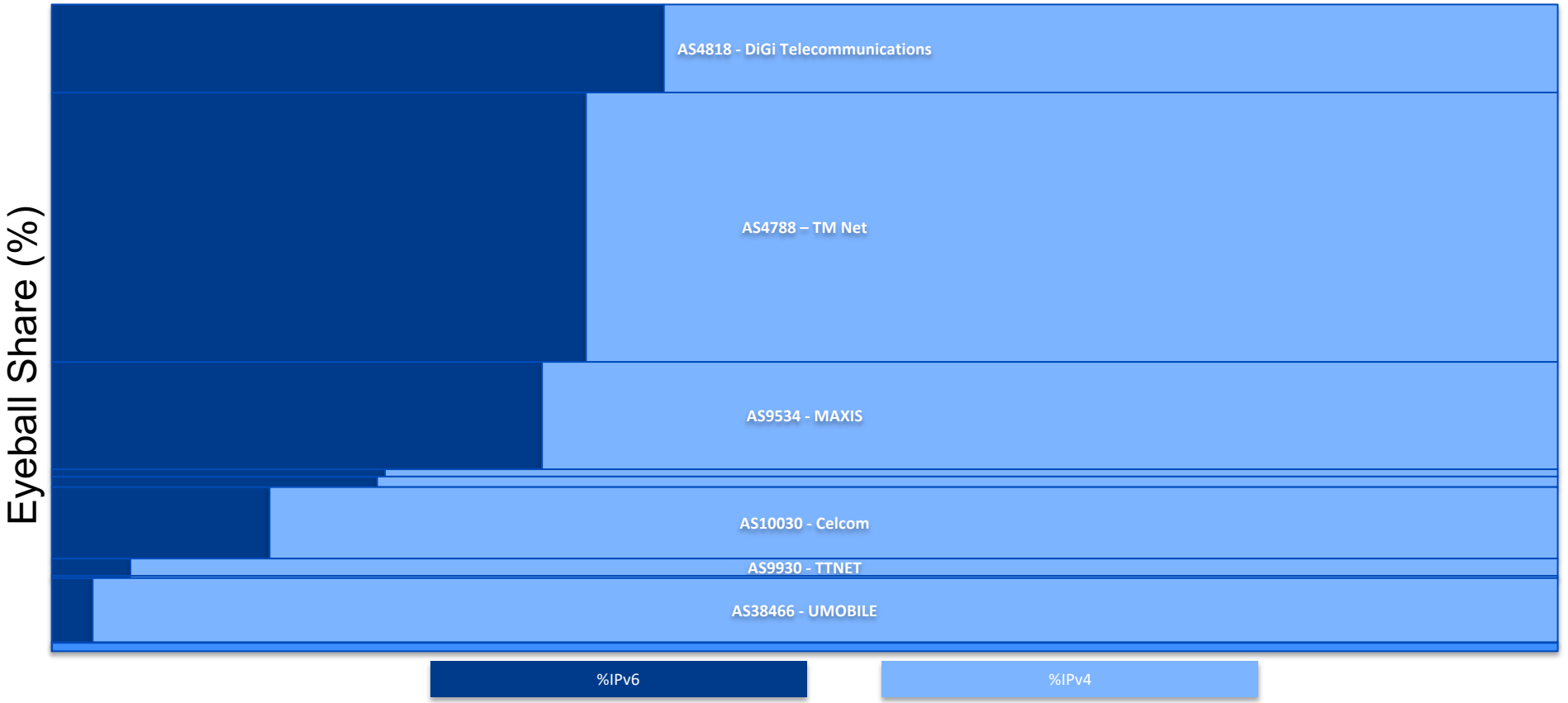
Malaysia IPv6 End-User Readiness



Malaysia IPv6 leaderboard

ASN	Organization	IPv6 capable (%)
4818	DiGi Telecommunications	58.73
9534	Maxis	46.90
38466	U Mobile	40.58
10030	Celcom	35.94
4788	TM Net	35.12
38322	WEBE Digital	26.04
9930	TTNET	5.26
45960	YTL Communications	3.08
38044	GITN	2.75

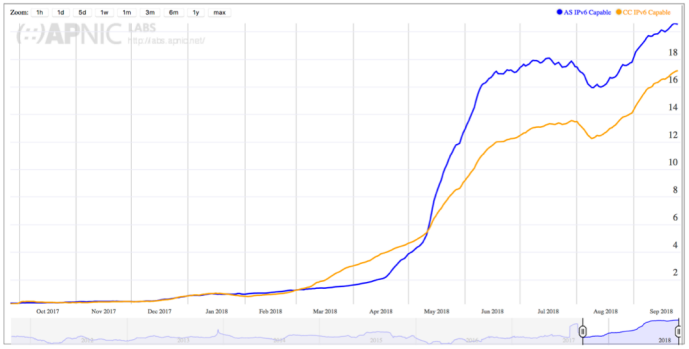
Malaysia IPv6 leaderboard

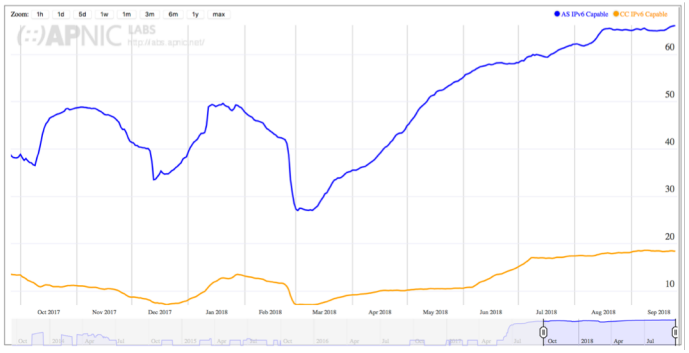


Three-stages of IPv6 Growth

Fast growth driven by single, early market driver

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



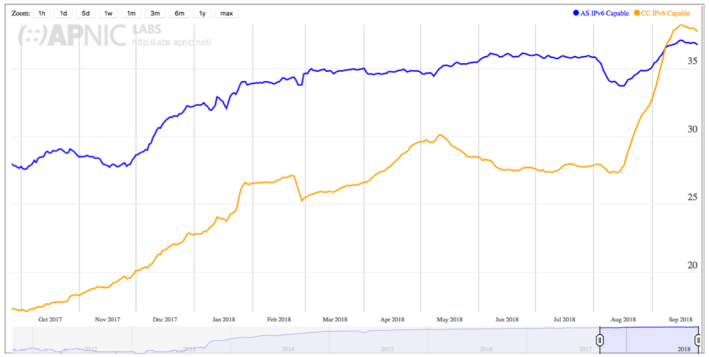


Initial roll-out followed by spread to other Internet Service Providers

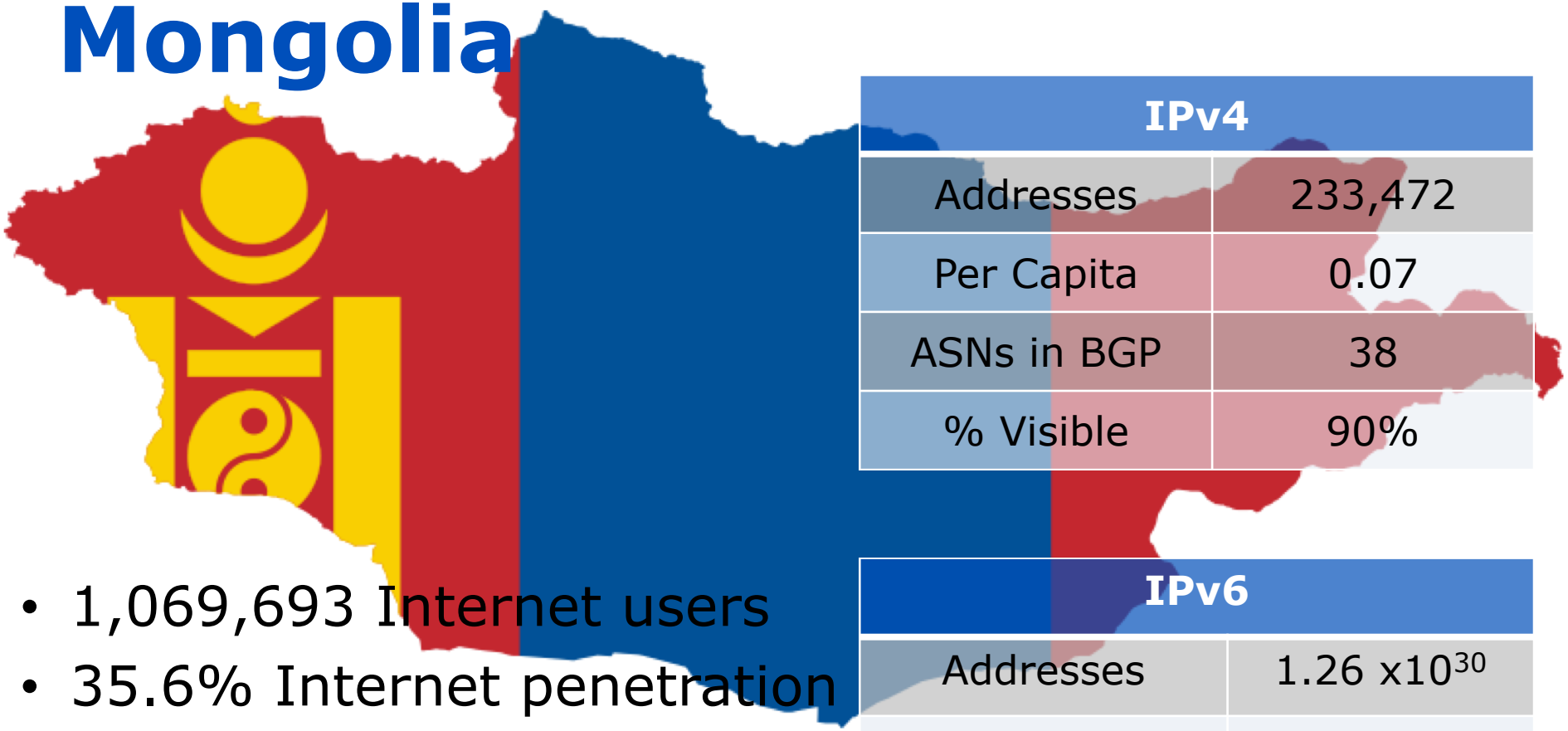
- *Incld. India, New Zealand, Sri Lanka, Thailand, Viet Nam*

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

- *Incld. Japan, Malaysia, Singapore*



Mongolia

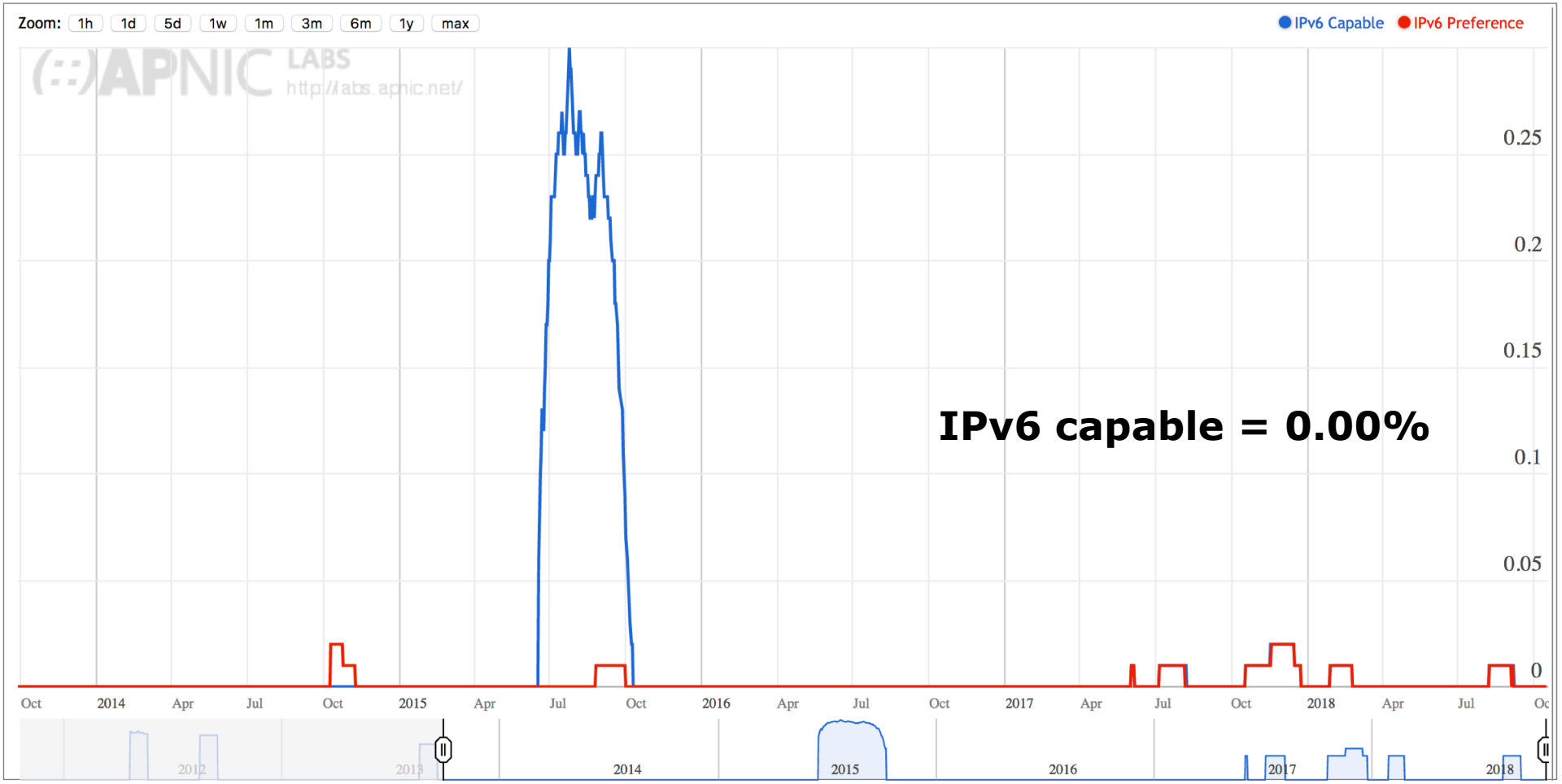


- 1,069,693 Internet users
- 35.6% Internet penetration
- 45 ASNs
- 0.00% IPv6 readiness

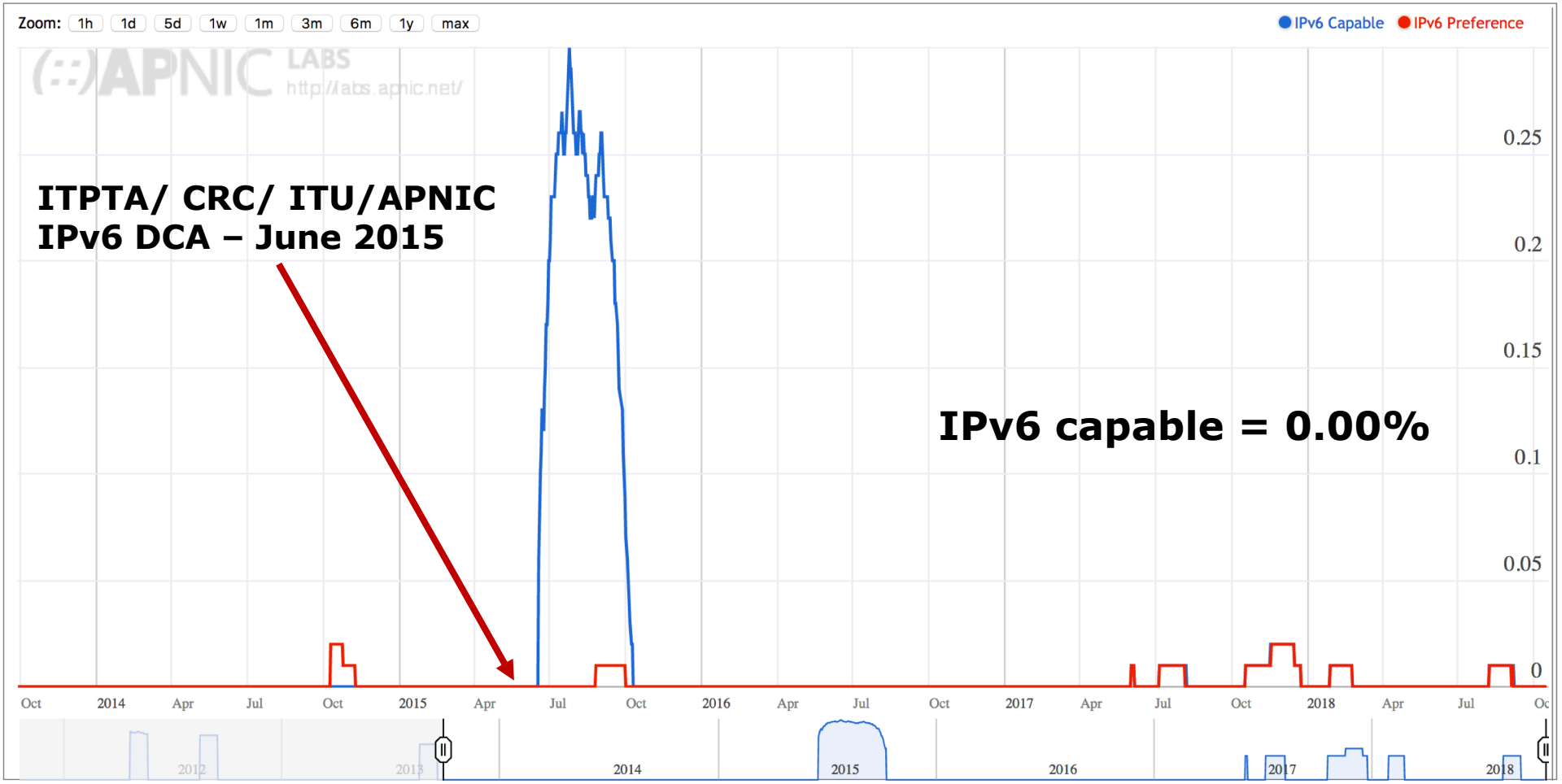
IPv4	
Addresses	233,472
Per Capita	0.07
ASNs in BGP	38
% Visible	90%

IPv6	
Addresses	1.26×10^{30}
Per Capita	4.06×10^{23}
ASNs in BGP	6
% Visible	19%

Mongolia IPv6 End-User Readiness



Mongolia IPv6 End-User Readiness



Mongolia IPv6 leaderboard

ASN	Organization	Delegated Prefix	Routed?
58598	Comtel	2403:d700/32	Yes
55805	Mobicom	2405:600::/32 2405:600:1000::/48	Yes
17882	Unitel (MCS)	2405:5700::/32	Yes
133453	Mogul Services	2001:df4:e800::/48	Yes
9484	Mobinet	2407:6400::/32	Yes
45204	Gemnet	2401:d600::/32	Yes

7 out of 21 IPv6 delegations to organizations in Mongolia visible in BGP

IPv6 in Action: Performance

- **Is IPv6 as robust as IPv4?**
  - Do all TCP connection attempt succeed?
    - Connection failure = No ACK for acknowledged SYN
  - IPv4 connection failure sits at 0.2%
  - IPv6 connection failure sits at 1.8%

[source : http://www.potaroo.net/presentations/2016-02-10-ad-measurement.pdf]

IPv6 in Action: Performance

- **Is IPv6 as fast as IPv4**? (IPv6 unicast)
  - Comparison of RTT (e2e)
    - Time since SYN till ACK (factors out any congestion issues)
  - IPv6 is faster about half of the time
    - 36-90ms faster
  - **IPv6 as fast as IPv4**

[source : http://www.potaroo.net/presentations/2016-02-10-ad-measurement.pdf]

IPv6 in Action: Performance

- **Is IPv6 as fast as IPv4**? (IPv6 unicast)
  - Comparison of RTT (e2e)
    - Time since SYN till ACK (factors out any congestion issues)
  - IPv6 is faster about half of the time
    - 36-90ms faster
  - **IPv6 as fast as IPv4**
- **Testing HTTP Traffic**
  - TechArk Network Operator Measurement Activity (NOMA) conducted preliminary tests of IPv6 performance for HTTP traffic using RIPE Atlases.
  - Found performance of IPv6 is better when measuring to a "near" target

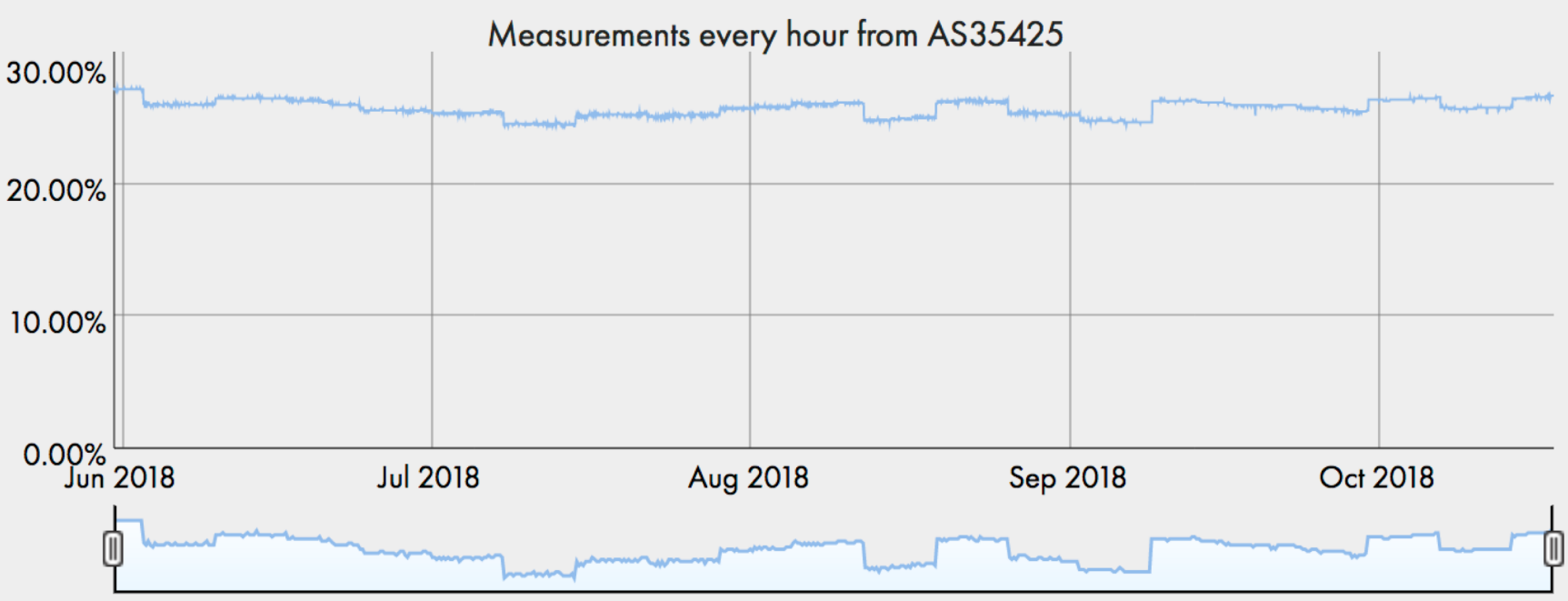
[source: https://blog.apnic.net/2017/09/29/network-operator-perspective-ipv6-performance/]

IPv6 in Action: Performance

- **Is IPv6 as fast as IPv4**? (IPv6 unicast)
  - Comparison of RTT (e2e)
    - Time since SYN till ACK (factors out any congestion issues)
  - IPv6 is faster about half of the time
    - 36-90ms faster
  - **IPv6 as fast as IPv4**
- **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%.**

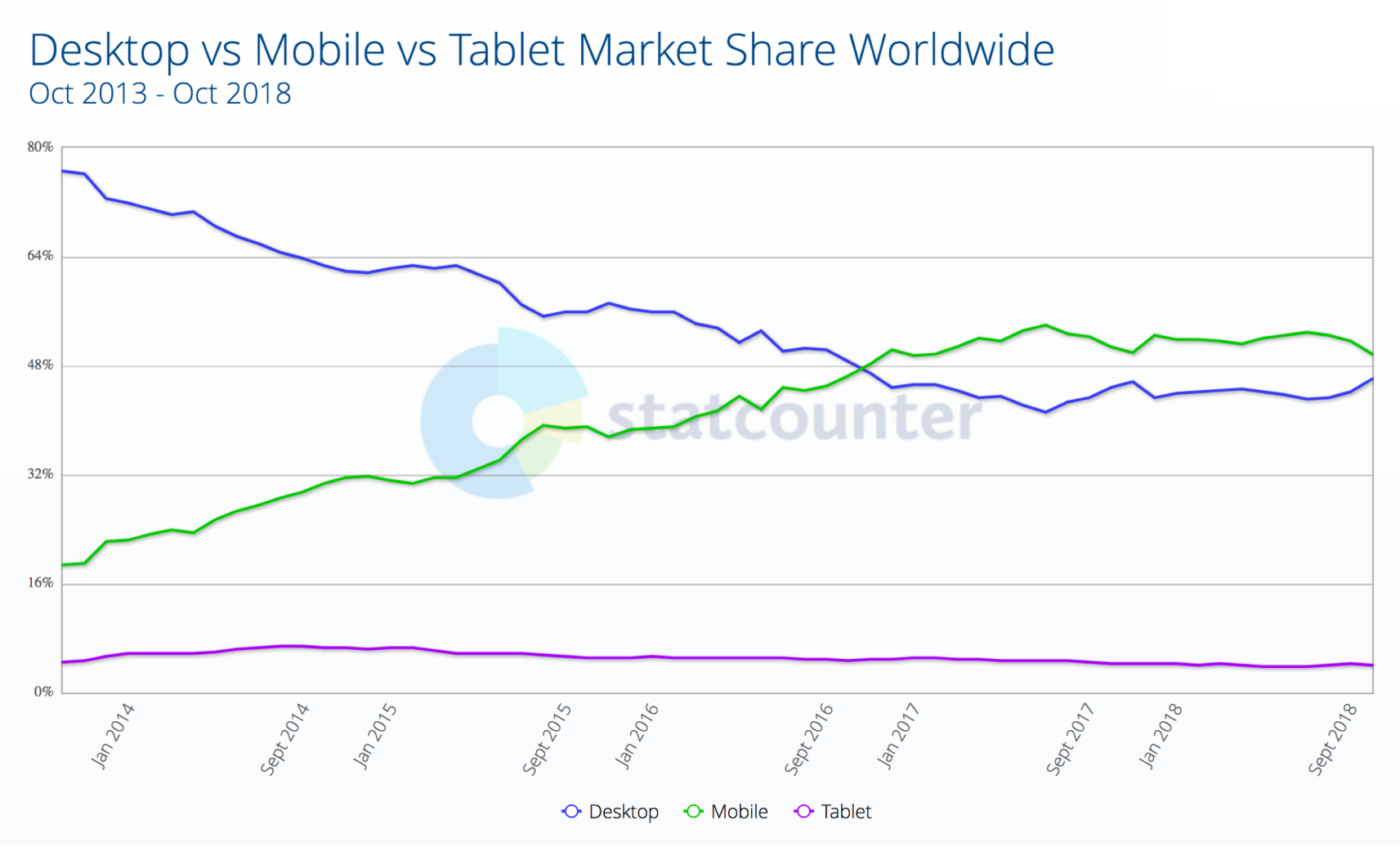
[source : https://blog.apnic.net/2016/05/13/linkedin-ipv6-measurements/]

IPv6 in Action: Content



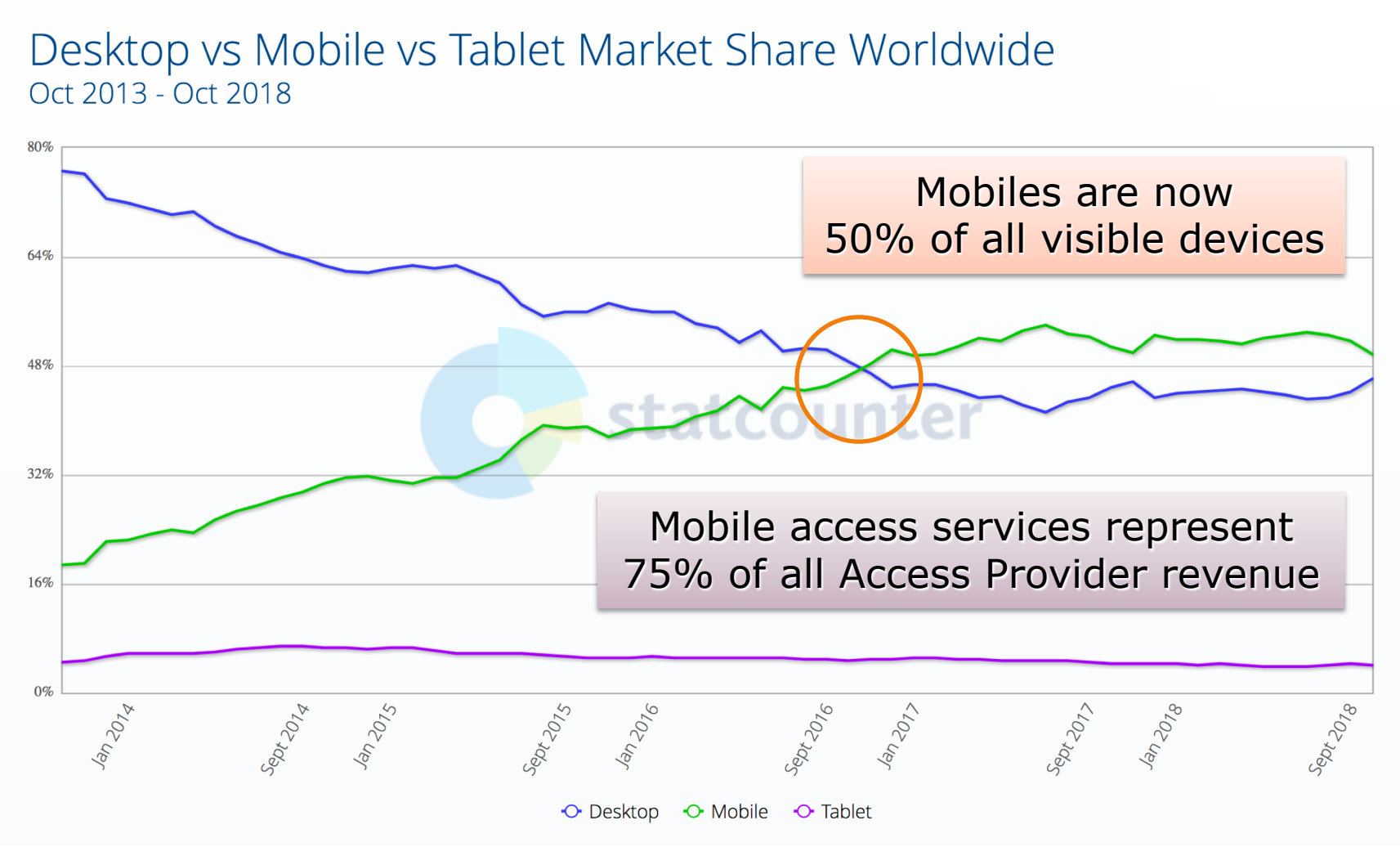
[source : http://www.worldipv6launch.org/measurements/]

Industry Trend: Devices



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

Industry Trend: Devices



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

IPv6 in Action: Mobile Devices

OS	Version	Available by default	DHCPv6
Android	4.4	Yes	No
iOS	4.1	Yes	Yes
Windows Phone	8.1	Yes	Yes

- Android and Windows Phone support 464XLAT
- KaiOS, as installed on JioPhone, supports dual-stack IPv6
- Apple iOS IPv6-only network support since version 9. Reports of Carrier Update for dual-stack since atleast iOS 11.3.
- Since 2016 all Apple AppStore apps must include IPv6 support

[source : https://getipv6.info/display/IPv6/3GPP+Mobile+Networks]

IPv6 in Action: Mobile Networks

Carrier	Economy	Note
Verizon Wireless	USA	Deployed dual stack transition technology in 2011
T-Mobile	USA	Deployed 464XLAT transition technology in 2012
SK Telecom	Korea	Deployed 464XLAT transition technology in 2014
Telstra	Australia	Deployed 464XLAT transition technology in 2016
Reliance Jio	India	Deployed dual stack transition technology in 2016
AIS	Thailand	Deployed dual stack transition technology in 2016 (Fiber) and 2017 (3G/4G)
Bhutan Telecom	Bhutan	Deployed dual stack transition technology in 2018 (3G/4G)
Chunghwa Telecom	Taiwan	Deployed dual stack transition technology in 2018

Where are we now?

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

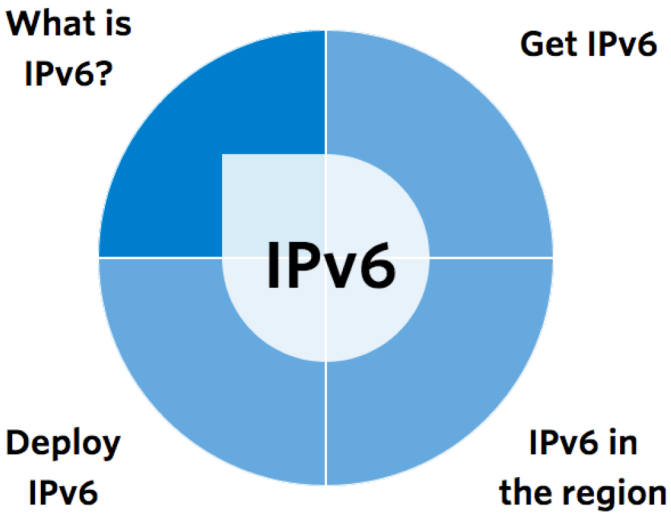
– ISOC State of IPv6 Deployment (2018)

- Global IPv6 end-user readiness is **15.99%**
  - **60.36%** of network operators in the Asia-Pacific have IPv6 resources.
  - **25.8%** of Global Autonomous Systems announce IPv6 (HE, 2018)
- IPv6 end-user readiness is increasing across diverse economy profiles.
- Once fully enabled, IPv6 usage increases quickly within networks.
- Common trend sees three stages of economy readiness.
- Mobile driven growth of connectivity and IPv6 deployment
- Observed preference for dual-stack transition technology in recent deployments
- Positive signs for future readiness growth, especially as vendor support grows.

APNIC

Get IP | Manage IP | Training | Events | Research | Community | Blog | About | Contact

IPv6@APNIC



What is IPv6? | Why is it important? | What does IPv6 mean to me? | Benefits

apnic.net/ipv6

баярлалаа!

Thank You!

APNIC