Where we are now: IPv6 deployment update

Toward development of Brunei IPv6 roadmap

IPv6 Seminar, hosted by AITI, Brunei

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APNIC

Agenda

- IPv6 and need for migration
  - Introduction to IPv6
  - Importance to transition to IPv6
- Future of the Internet and business
  - Internet business growth: Where is it coming from?
- IPv6 deployment: where are we now?
  - IPv6 deployment status – review of statistics

<Break>

- Case studies (anecdotal stories)
- Governments' initiative in the AP region
  - National guidelines and mandates
- Preparation for the afternoon session
- Useful resources

IPv6 and need for migration

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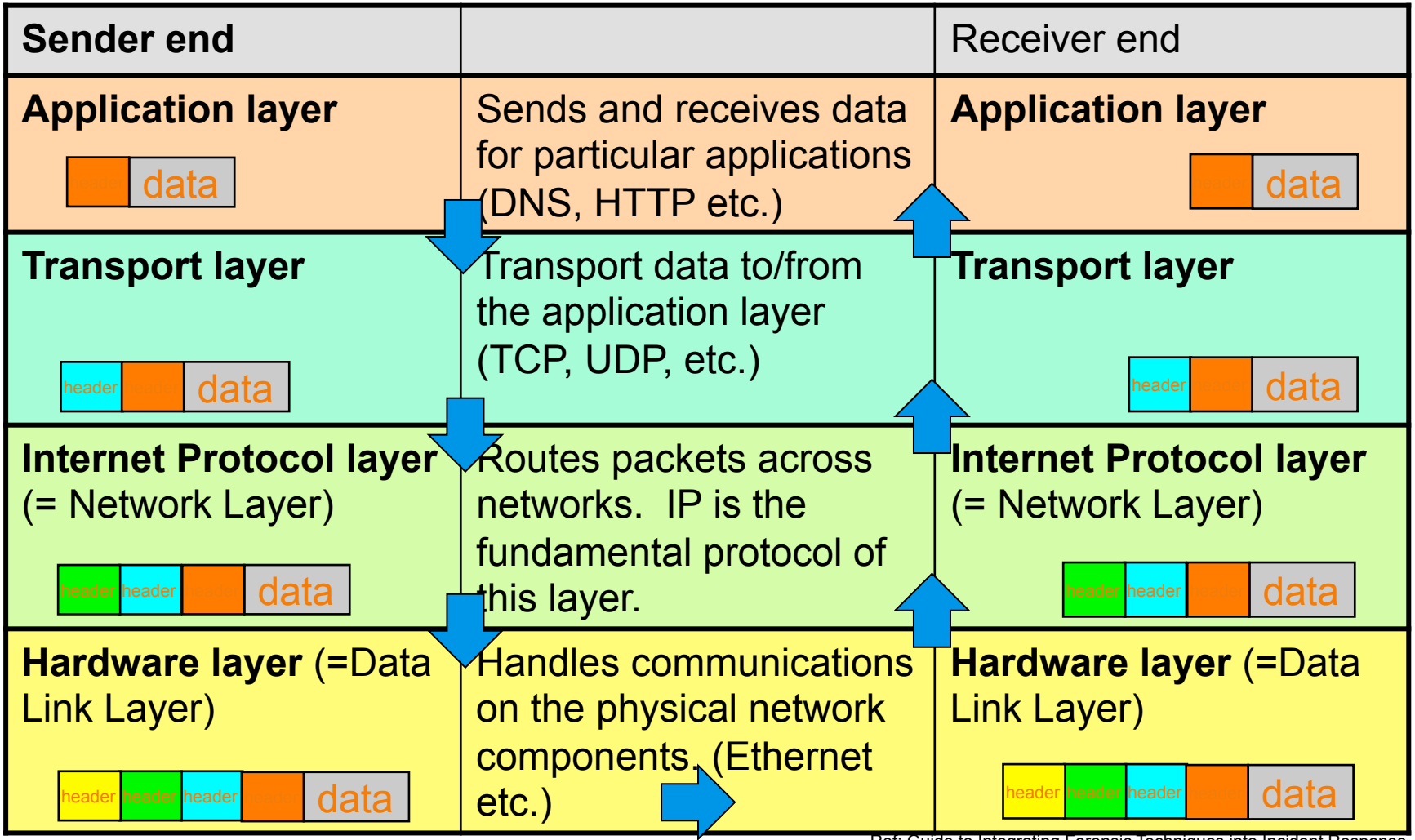
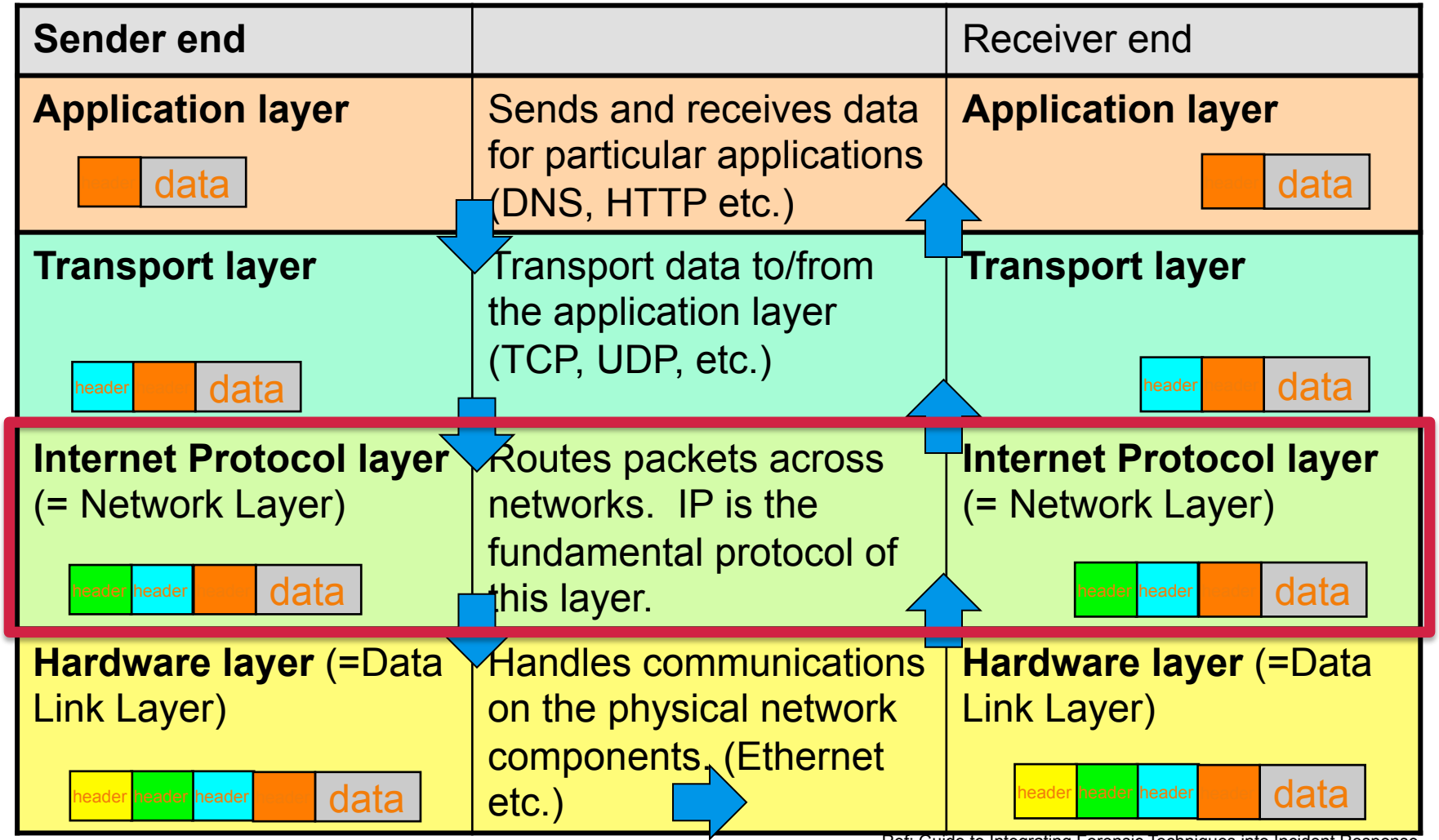
Staged (layered) communication in the Internet



Ref: Guide to Integrating Forensic Techniques into Incident Response

Staged (layered) communication in the Internet



Ref: Guide to Integrating Forensic Techniques into Incident Response

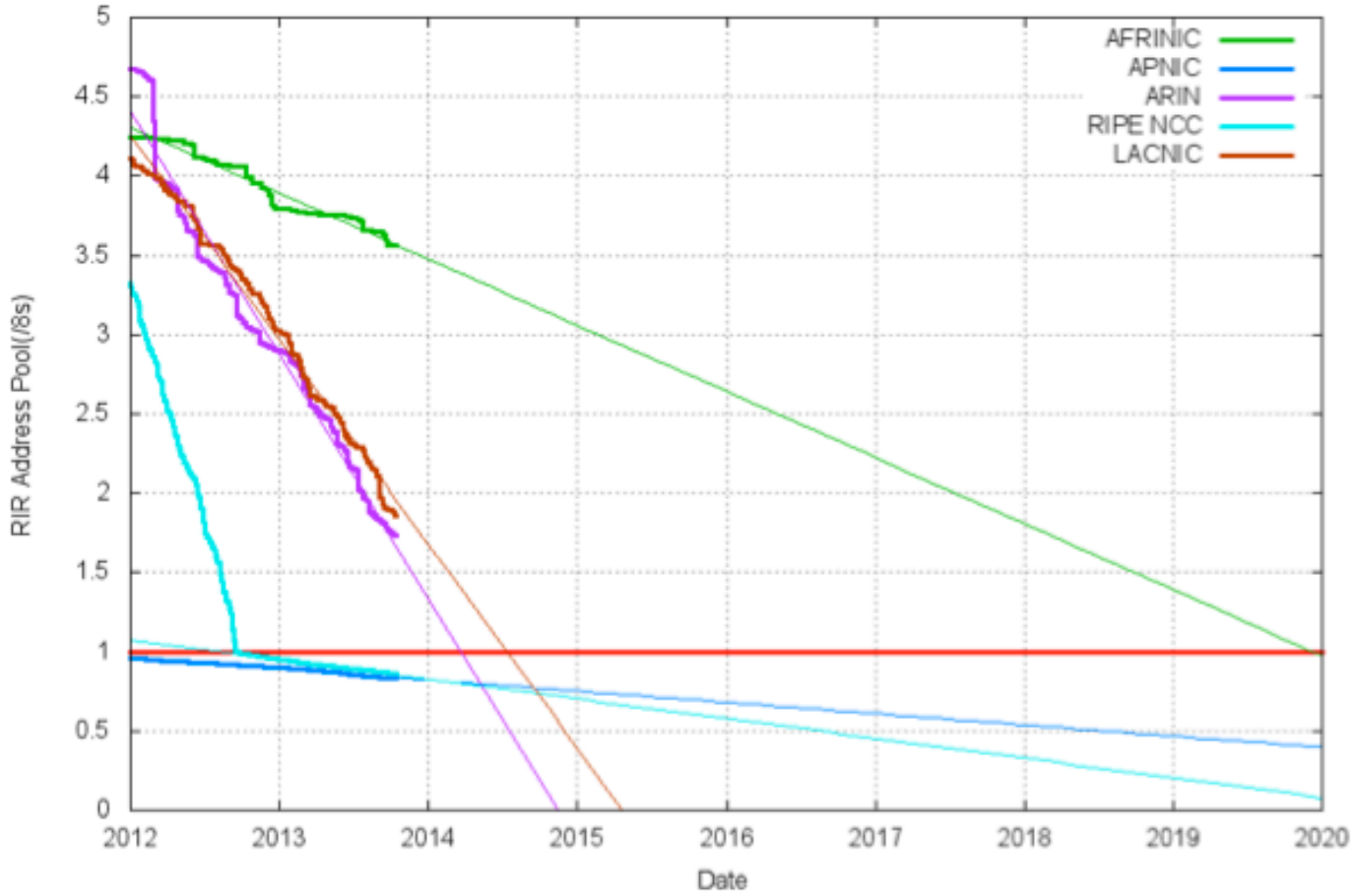
Internet Protocol (IP)

- IP = A protocol used for communicating data across the Internet
- Services provided by IP
  - Bridge a gap between heterogeneous networks (for example, Ethernet, Wi-Fi, token ring and so forth)
  - Specify communication parties
    - Who sends packets to whom?
    - IP addresses
  - Define routes to send packets
- In terms of functionality of IP, IPv4 and IPv6 exactly do same
- Different from domain names
  - “A name indicates what we seek. An address indicates where it is. A route indicates how to get there”

IP version history

	Internet Protocol version 4 (IPv4)	Internet Protocol version 6 (IPv6)
Deployed	1981	1999
Address Size	32-bit number	128-bit number
Address Format	Dotted Decimal Notation: 192.0.2.76	Hexadecimal Notation: 2001:DB8:0234:AB00:0123:4567:8901:ABCD
Prefix Notation	192.0.2.0/24	2001:DB8:0234::/48
Number of Addresses	2^{32} = ~4,000,000,000	2^{128} = ~340,000,000,000,000,000,000,000,000,000,000,000

Projection of IPv4 address exhaustion



Projection of consumption of Remaining RIR Address Pools

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

IPv4 and IPv6

- Functionalities are exactly same, but there are some differences at the operational level. E.g.,
  - Address size increase requires network operators new consideration while designing networks
    - Subnet boundaries is counter intuitive
  - Border Gateway Protocol (BGP) configuration (protocol to communicate between external parties' networks)
    - Another set of configuration (IPv6 address family) in addition to IPv4 configuration (IPv4 address family) is required
  - Open Shortest Path First (OSPF) configuration (used inside of an operator's network)
    - OSPFv2 (for IPv4) and OSPFv3 (for IPv6) are very different to each other
  - Domain Name System (DNS) configuration
    - Another configuration (AAAA record) in addition to IPv4 configuration (A record) is required

The Situation Today

- Public IPv4 Address space is running out
  - APNIC and RIPE NCC are in their “austerity” phases
  - ARIN and LACNIC is a few months away from running out
  - AfriNIC still have about 2 years of IPv4 left
- The Internet infrastructure operators have 3 simple choices facing them:

1. **Do Nothing**
2. **Prolong IPv4**
3. **Deploy IPv6**

Choice 1: Doing Nothing

- Advantages:
  - Business as usual, they have enough IPv4 for the foreseeable future
  - Easiest strategy – no investment needed
- Disadvantages:
  - Depends on IPv4 address availability
    - /22 (1024 addresses only from APNIC and RIPE NCC)
    - Limited transfer market activity
    - Address transfer costs
  - Customers have no access to IPv6-only content
    - If/when IPv6-only content is available
  - Lagging behind early adopters
    - Lacking operational experience in the new protocol

Choice 2: Prolonging IPv4

- This means:
  - Deploying NAT more widely
  - IPv4 address trading/market
- Advantages:
  - Continues what is known
  - Public addresses still available for ISP public infrastructure
- Disadvantages:
  - Customers forced to use NAT
  - Investment in large NAT devices
  - Rearchitecting network infrastructure around NAT
  - Address reputation (NAT as well as traded addresses)

Choice 2: Prolonging IPv4

- NAT issues:
  - Restricts provision of services to those with public addresses
  - Reputation of shared addresses
    - Behavioural, security, liability
  - Lawful intercept
  - Tracking and logging association of address/port and subscriber
  - Performance & scaling of NAT devices
  - Cost of “enterprise” scale NAT devices
  - Resource demands of some applications
  - Double or even Triple NAT likely
  - “How many ports does one user need?”

Choice 2: Prolonging IPv4

- Address transfer issues:
  - Routability of transferred addresses
  - Reputation of transferred addresses
  - More rapid growth of Internet routing table
  - Risk to integrity of routing system if transfers are unregistered
  - Cost to acquire addresses
  - Financial pressure on operators to dispose of addresses they still require

Choice 3: Deploying IPv6

- Original goal of IPv6 developers – Dual Stack
  - IPv6 running alongside IPv4
  - Public addresses for both IPv4 and IPv6
  - Once IPv6 universally deployed, IPv4 would be turned off
- Now:
  - Dual stack with public addresses still possible in some places
  - In other places, Dual Stack means public IPv6 and NATed IPv4
  - Not all network operators have deployed IPv6
  - Not all infrastructure devices can support IPv6
  - Meaning “transition” techniques required to “bypass” those

Choice 3: Deploying IPv6

- Advantages:
  - Network runs both IPv4 and IPv6
  - Once IPv6 universally available, IPv4 is simple to turn off
- Disadvantages
  - Depends on Public IPv4 address availability, or NATs
  - New protocol, staff training
  - New protocol, updated/new equipment
  - Extra resources on existing equipment (eg RIB/FIB limits)
  - Protocols are incompatible: IPv6 cannot talk to IPv4 and vice-versa
  - Updating end-user CPE

Choice 3: Deploying IPv6

- In addition to Dual Stack, Transition Techniques maybe also be required:
  - Means of getting IPv6-only to talk to IPv4-only

    NAT64
  - Transport IPv6 over IPv4-only infrastructure

    Tunnels & 6rd
  - Transport IPv4 over IPv6-only infrastructure

    DS-Lite, 464XLAT

Which choice will you make?

- Doing nothing
  - Costs nothing
- Prolonging IPv4
  - Impact of taking IPv4 addresses back from customers?
  - Economics of deploying NAT?
    - e.g. Lee Howard's (TimeWarner Cable) whitepaper on the economics of NATs
    - http://conference.apnic.net/data/36/cost-of-cgn_1377486548.pdf
  - Operational impact, depending on regulatory requirements
    - Lawful intercept, logging, user tracking, reputation
  - Address transfer costs and address reputation
    - Routing system integrity – may have addresses but are they routable?

Which choice will you make?

- Deploying IPv6
  - Apparently easiest option
  - Most network infrastructure devices support both IPv4 and IPv6
  - Devices not supporting IPv6 need upgrading/replacing
  - Staff training?
  - Operational management tools?
  - Last mile infrastructure impacts (especially if contracted)
  - Transition technologies needed (eg NAT64, 6rd, 464XLAT…)

IPv6 Deployment Choices? Summary

- Doing nothing feels safe
  - But is it future proof?
- Prolonging IPv4 uses familiar technologies
  - But what will it cost?
  - Will it scale?
  - What will the end-user impact be?
  - What will the operator impact be?
- Deploying IPv6 is new
  - Protocol looks and feels like IPv4
  - Infrastructure upgrades and training costs are real
  - Avoids the unknowns of prolonging IPv4 with more NAT

Future of the Internet and business

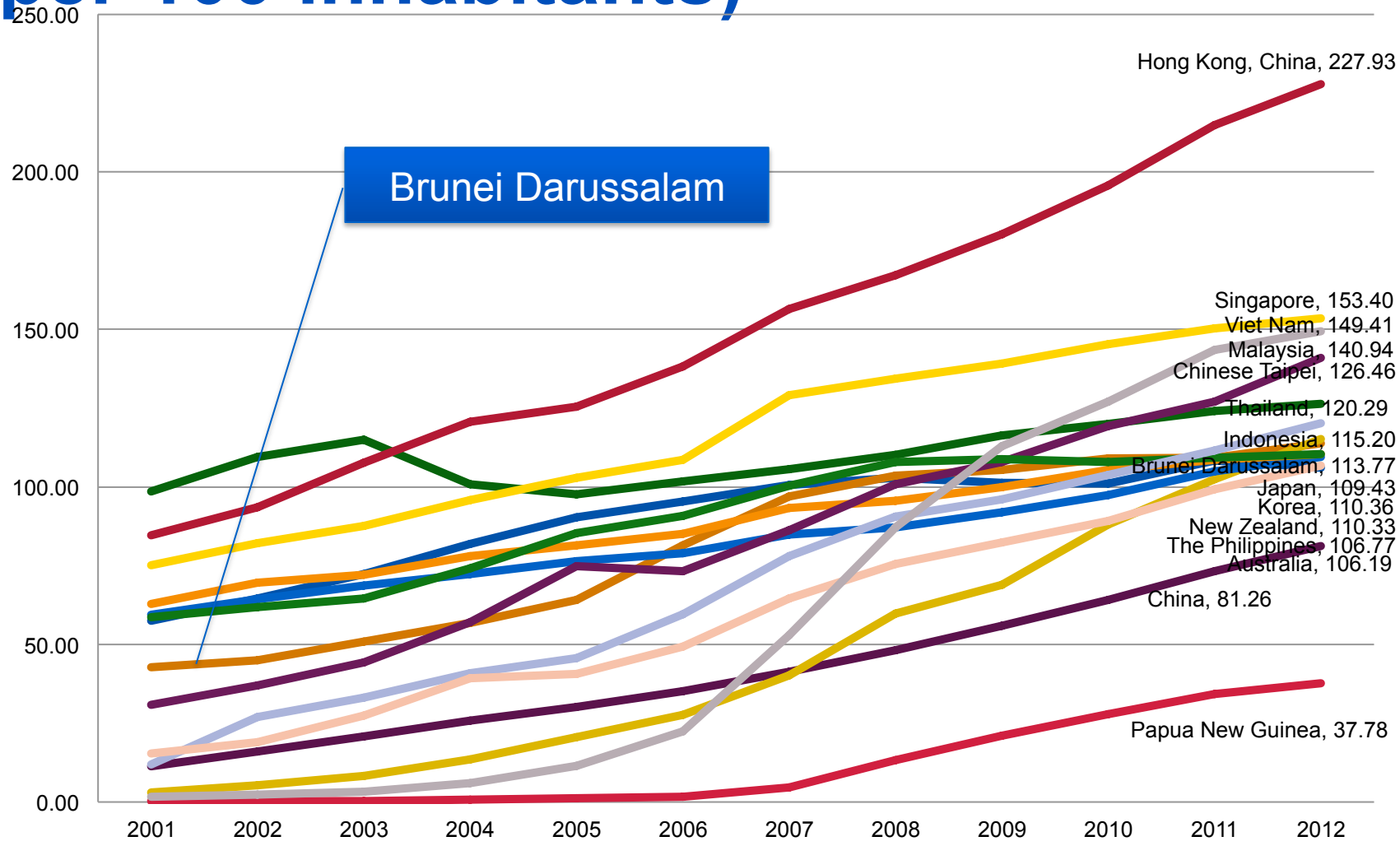
APNIC

Internet business growth
Where is it coming from?

- Internet is also growing at a tremendous rate in aspiring economies, but with distinctly different growth paths from those seen in developed economies.
- So from where is the growth is coming? The following charts show part of the answer.

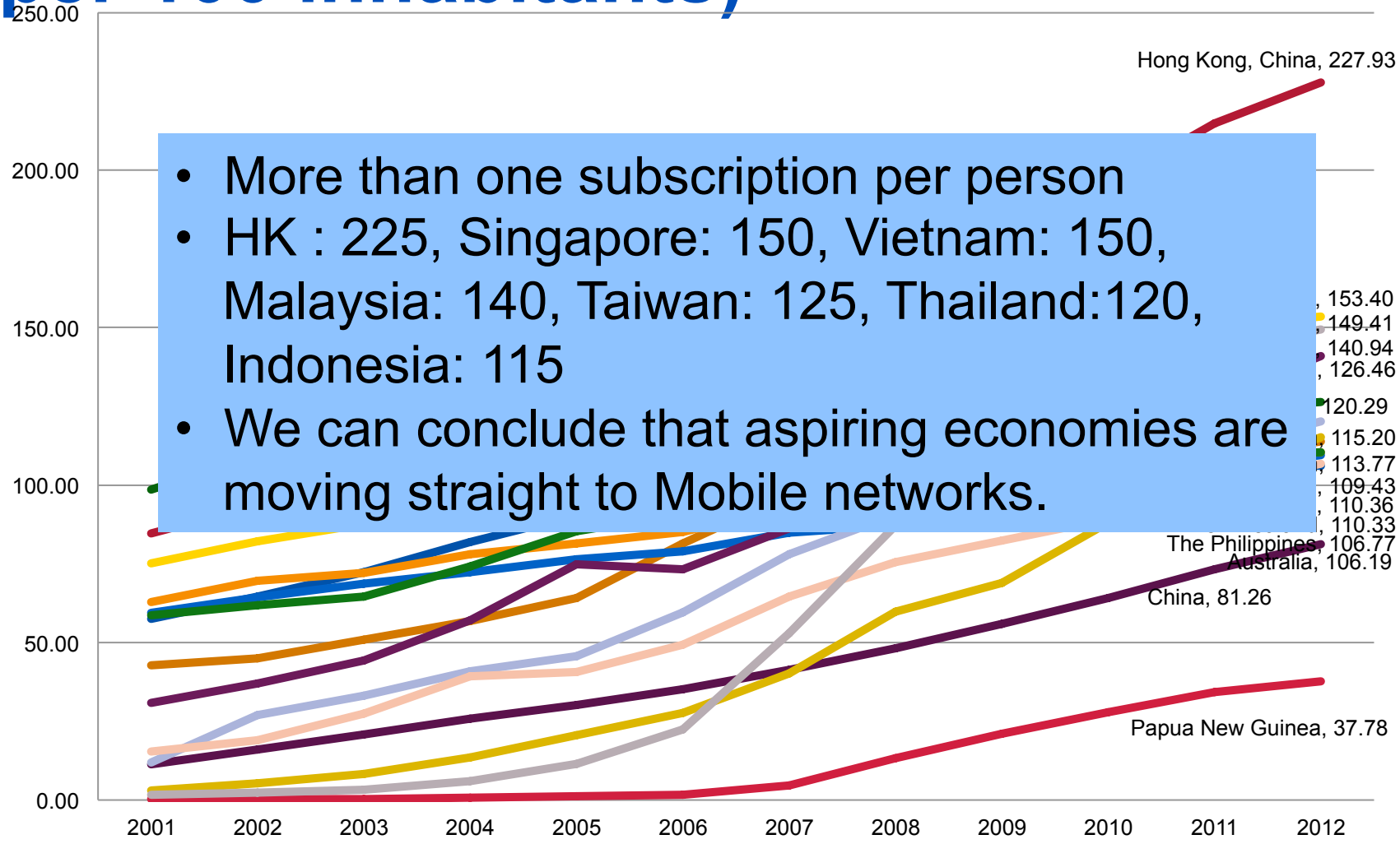
https://www.apnic.net/community/ipv6-program/ipv6-for-decision-makers

Mobile cellular subscription (per 100 inhabitants)



http://statistics.apec.org/index.php/key_indicator/index

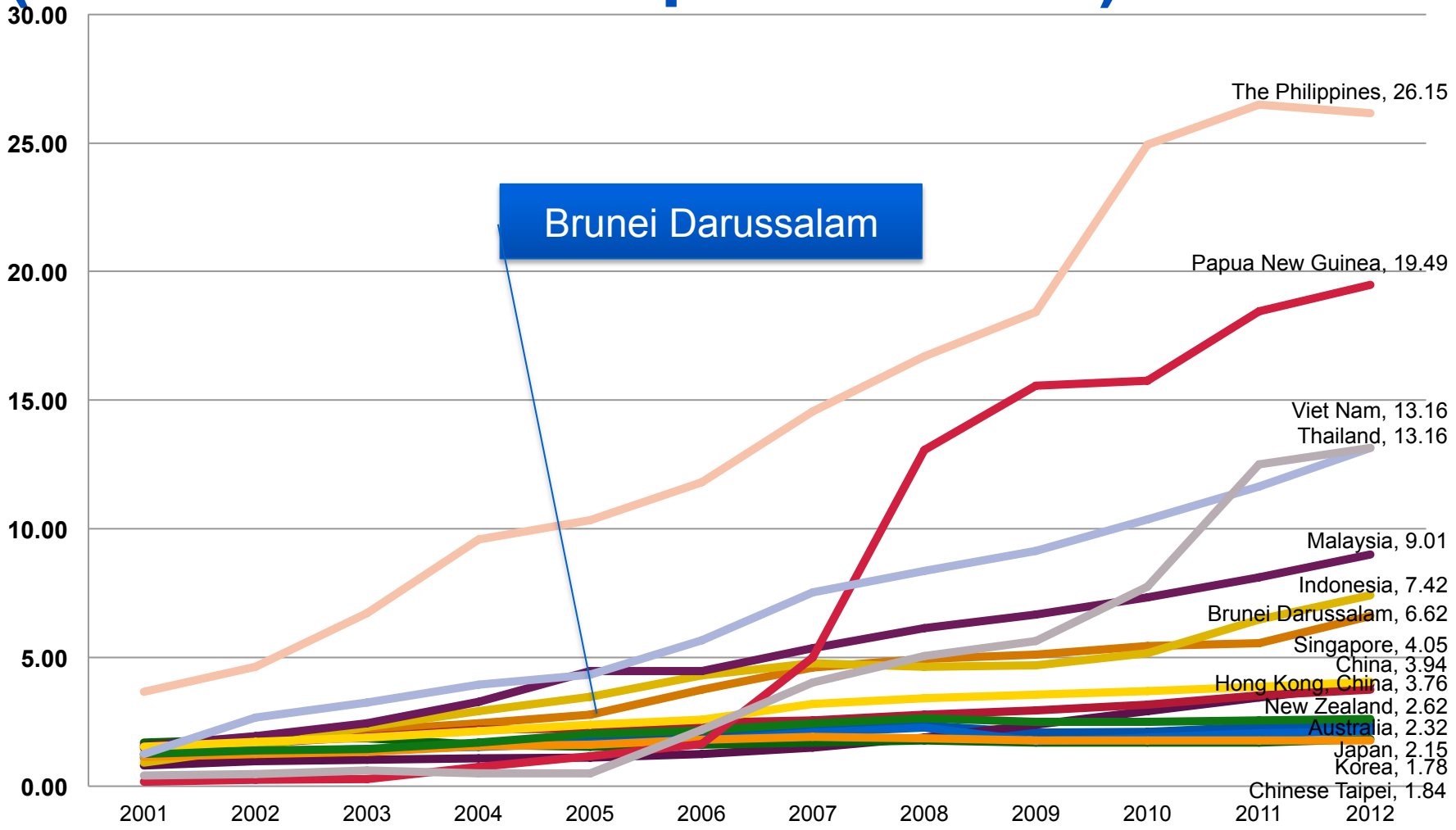
Mobile cellular subscription (per 100 inhabitants)



- More than one subscription per person
- HK : 225, Singapore: 150, Vietnam: 150, Malaysia: 140, Taiwan: 125, Thailand:120, Indonesia: 115
- We can conclude that aspiring economies are moving straight to Mobile networks.

http://statistics.apec.org/index.php/key_indicator/index

Mobile Cellular Subscriptions (ratio to fixed telephone lines)



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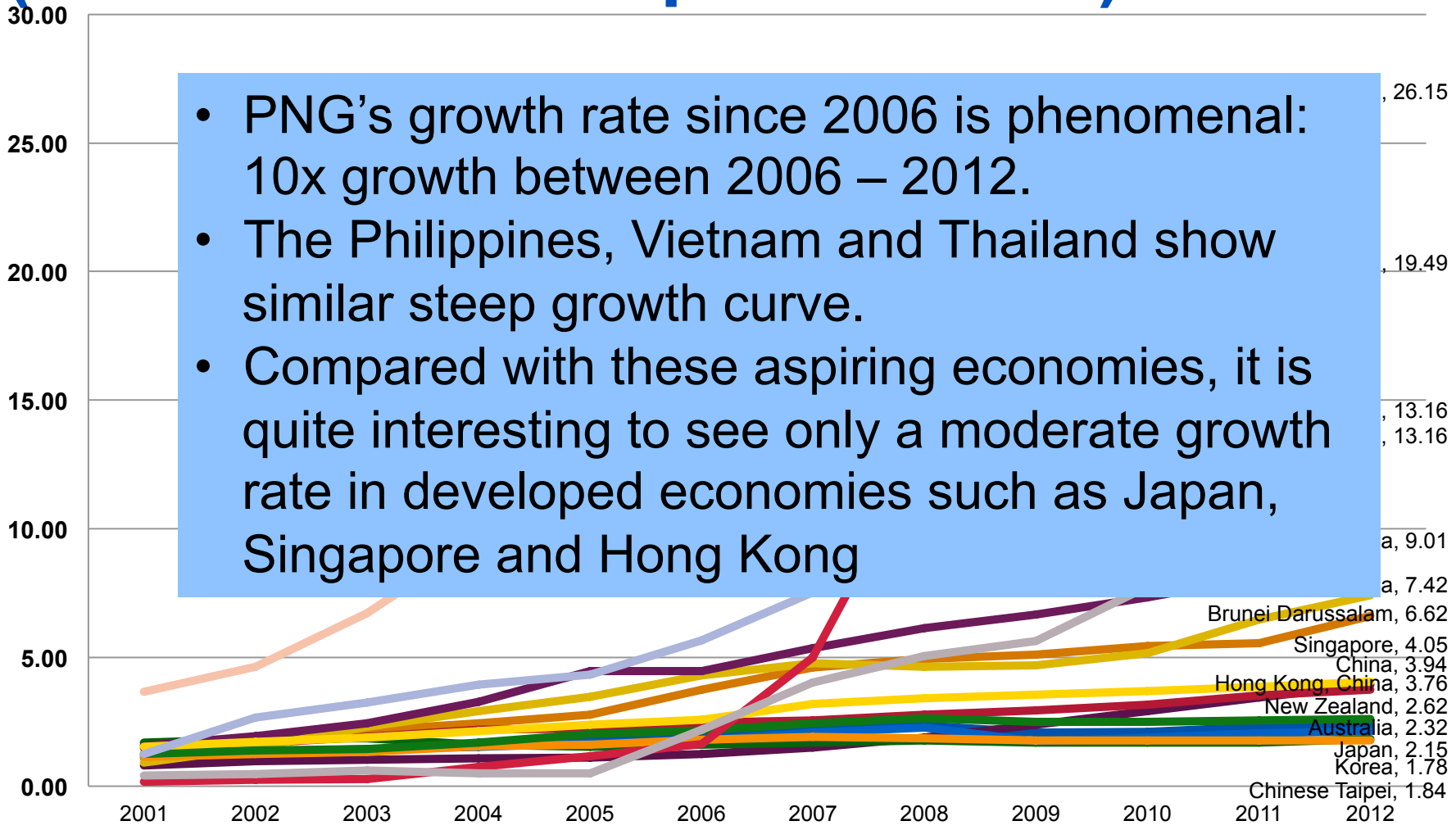


- PNG's growth rate since 2006 is phenomenal: 10x growth between 2006 – 2012.
- The Philippines, Vietnam and Thailand show similar steep growth curve.
- Compared with these aspiring economies, it is quite interesting to see only a moderate growth rate in developed economies such as Japan, Singapore and Hong Kong

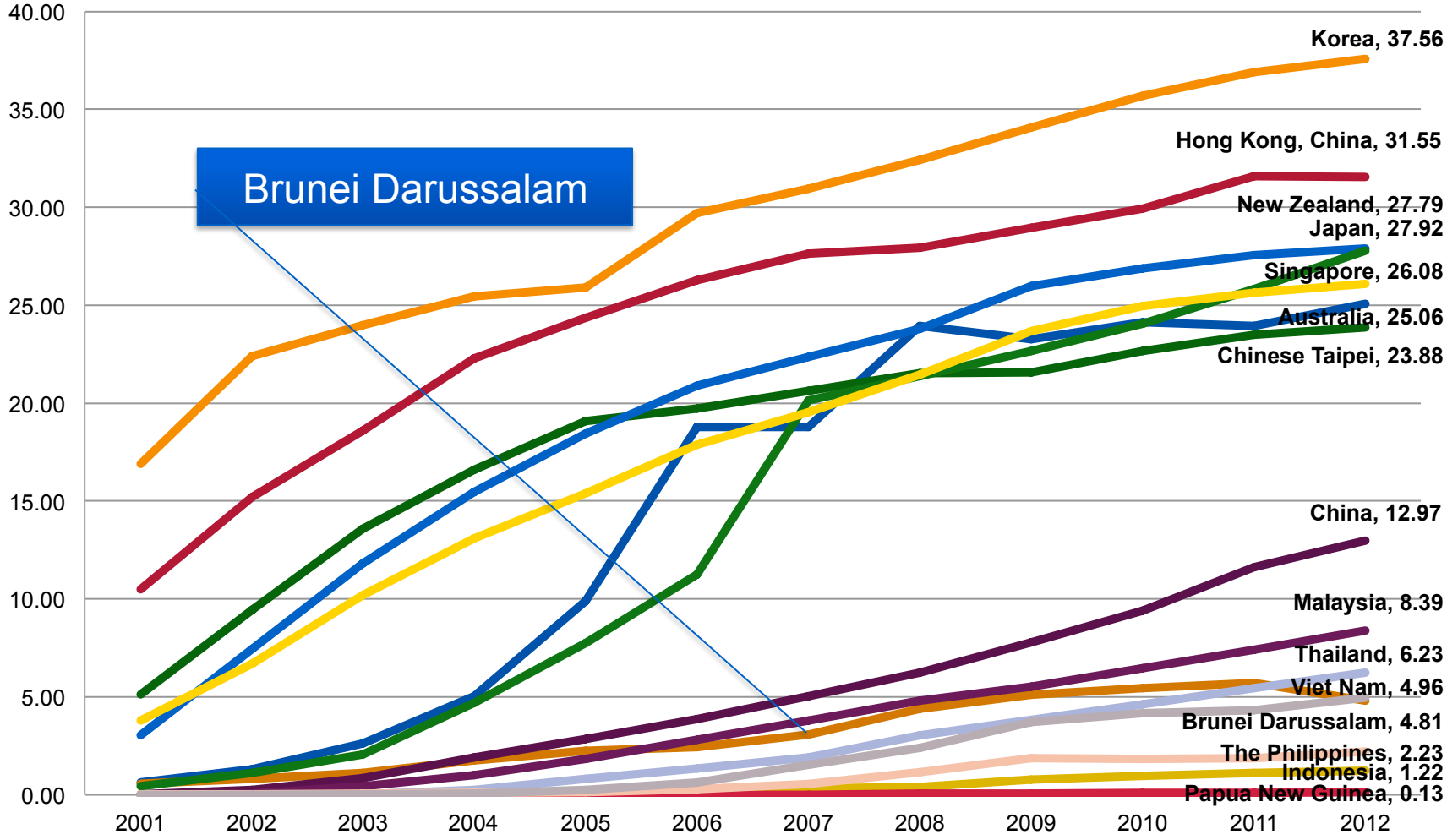
http://statistics.apec.org/index.php/key_indicator/index

Growth path in aspiring economies

- Given the recent robust increase in mobile devices such as smart phones and tablets, it is quite obvious that many Internet users in growing economies are accessing the Internet through mobile devices:
  - Most likely solely from mobile devices, compared with Internet users in developed economies.
- Mobile devices are a much lower cost to obtain than personal computers, and cellular networks are free from the high cost of cable installation on land.

https://www.apnic.net/community/ipv6-program/ipv6-for-decision-makers

Internet subscriptions, Broadband (per 100 inhabitants)



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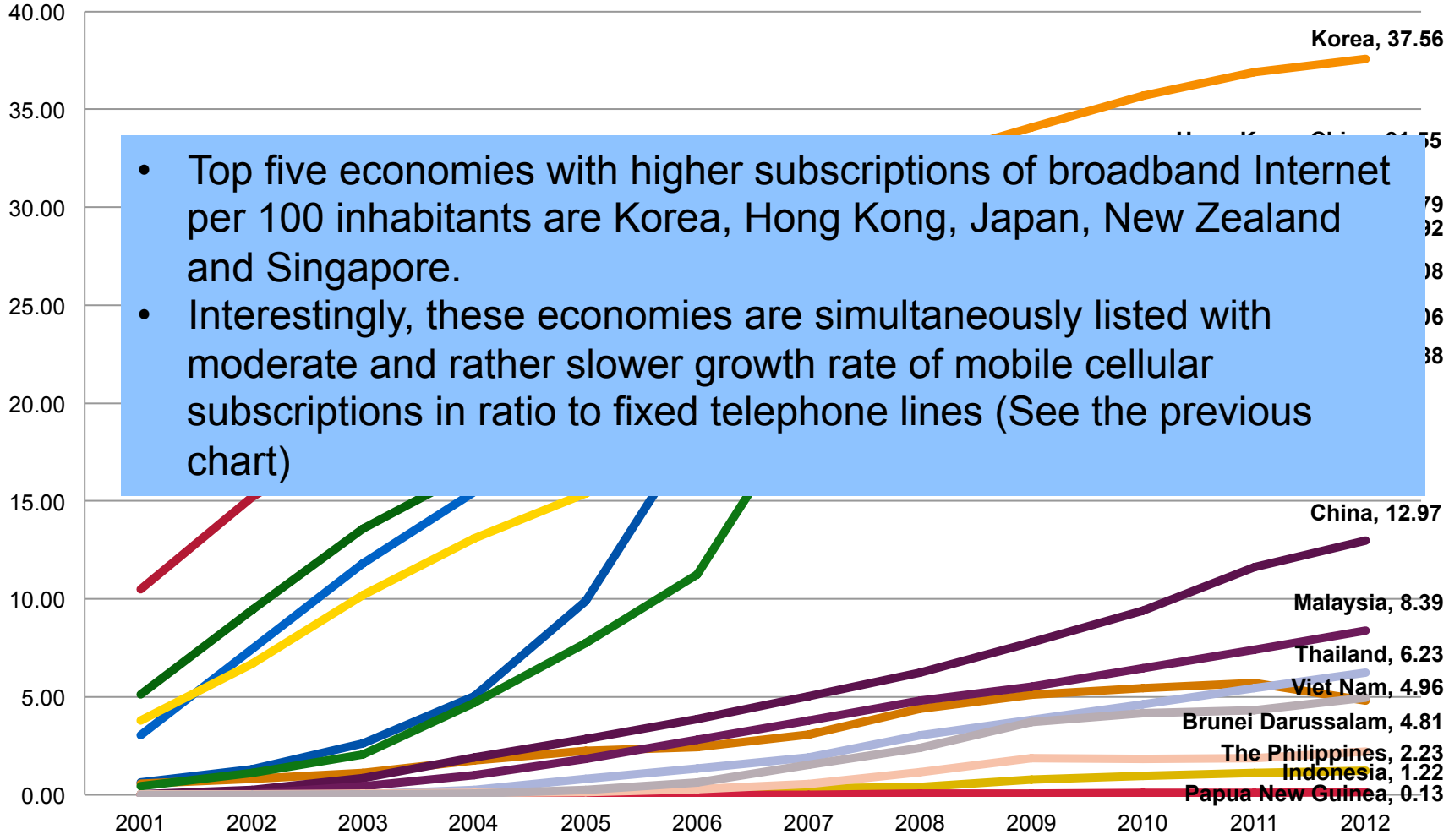


- Top five economies with higher subscriptions of broadband Internet per 100 inhabitants are Korea, Hong Kong, Japan, New Zealand and Singapore.
- Interestingly, these economies are simultaneously listed with moderate and rather slower growth rate of mobile cellular subscriptions in ratio to fixed telephone lines (See the previous chart)

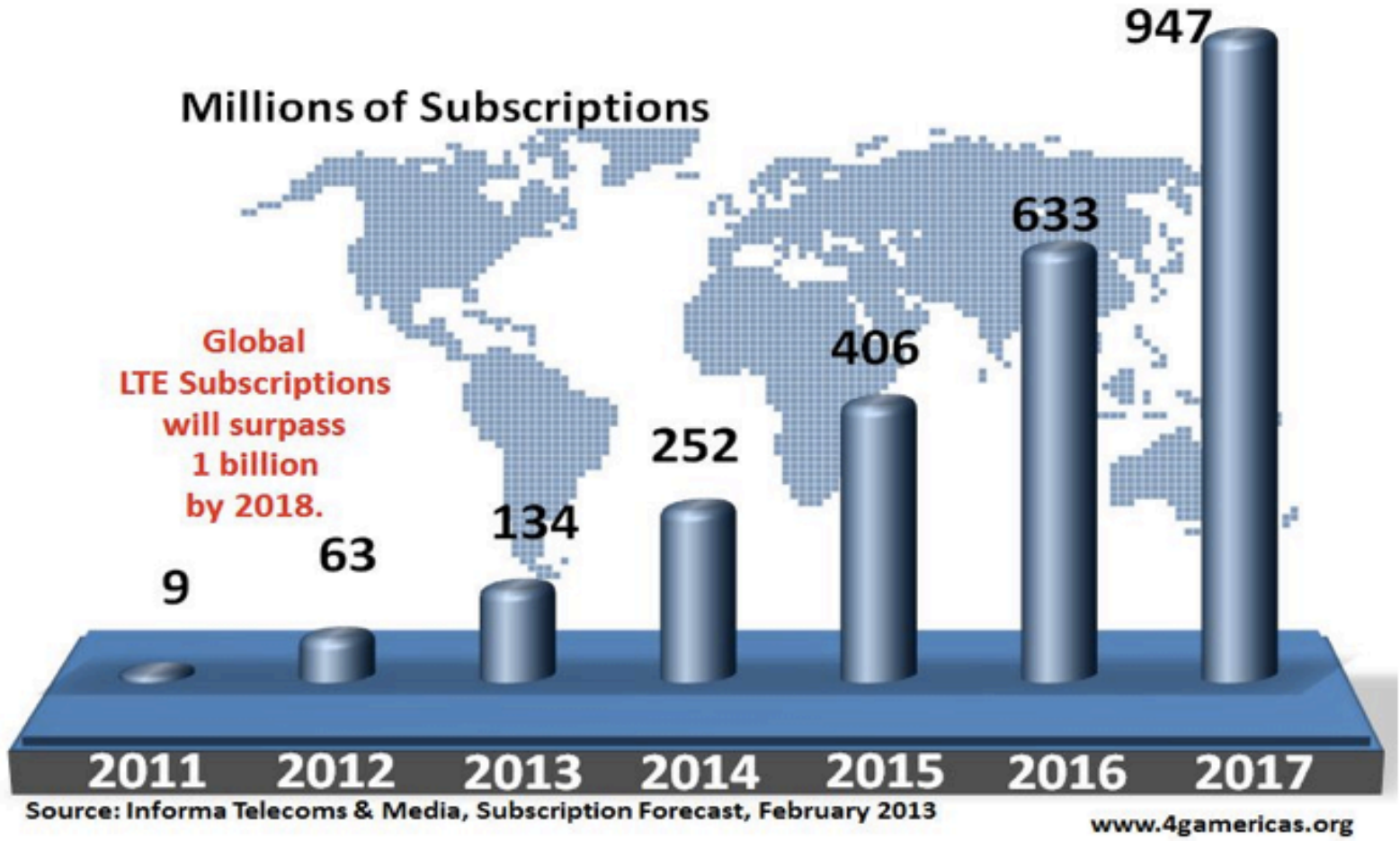
http://statistics.apec.org/index.php/key_indicator/index

Growth path of the Internet

- While fixed network broadband still provides an important base for Internet users in developed economies, mobile network access to the Internet has became a major foundation for both currently growing economies and developed economies
  - Mobile networks' role in currently growing economies is phenomenal.
- Such dynamic changes induced by rapid evolution of the infrastructure will bring in so many new Internet users into the market place.
- According to the McKinsey&Company's report:
  - In 2010, 310 million mobile devices were used to access the Internet in 30 aspiring economies out of 800 million worldwide.
  - It's almost 40% of the total and it is easy to imagine this trend will continue in the foreseeable future.

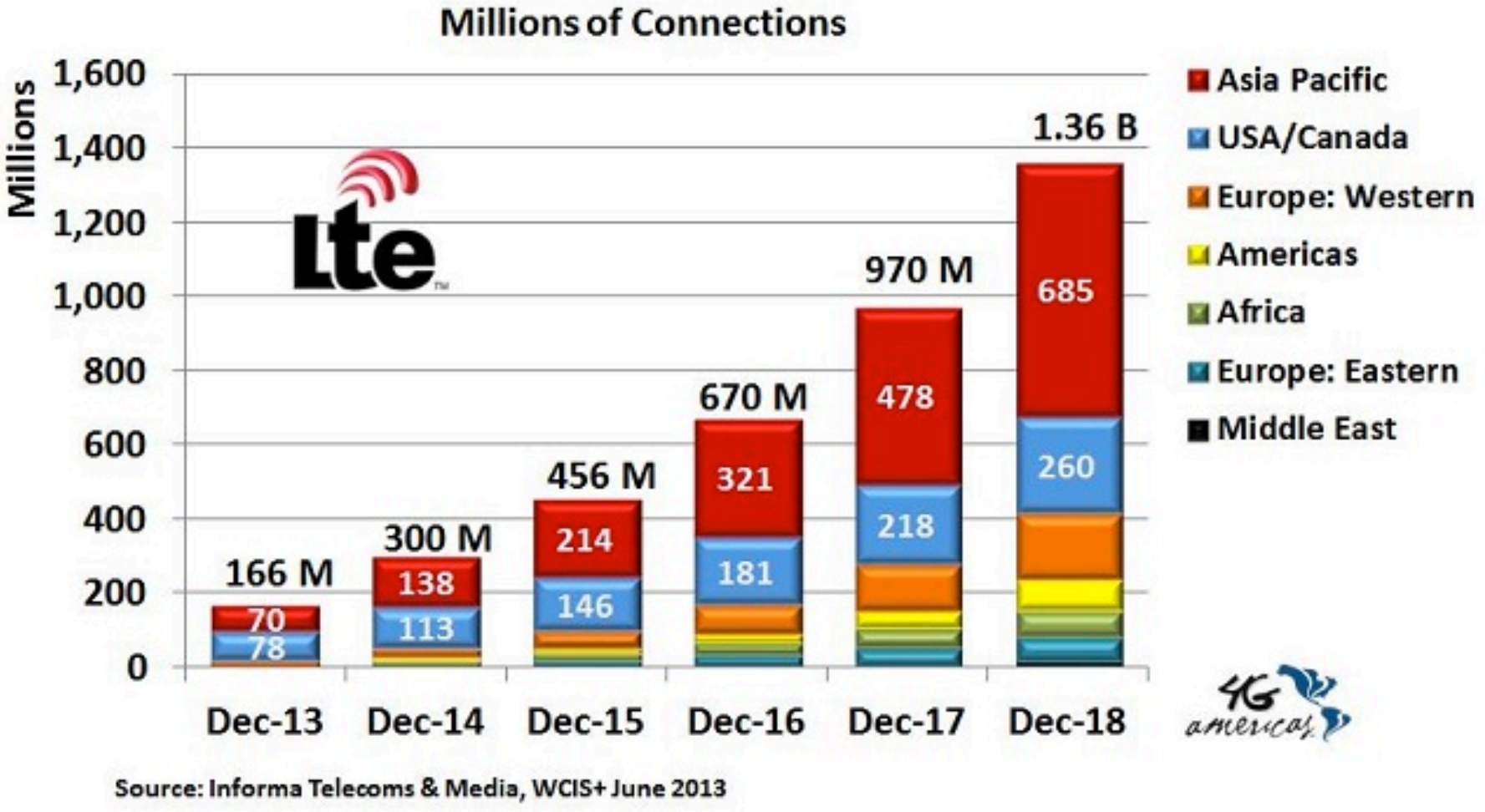
https://www.apnic.net/community/ipv6-program/ipv6-for-decision-makers

Global LTE growth focus



www.4gamericas.org/index.cfm?fuseaction=page&pageid=1781

Global LTE growth focus



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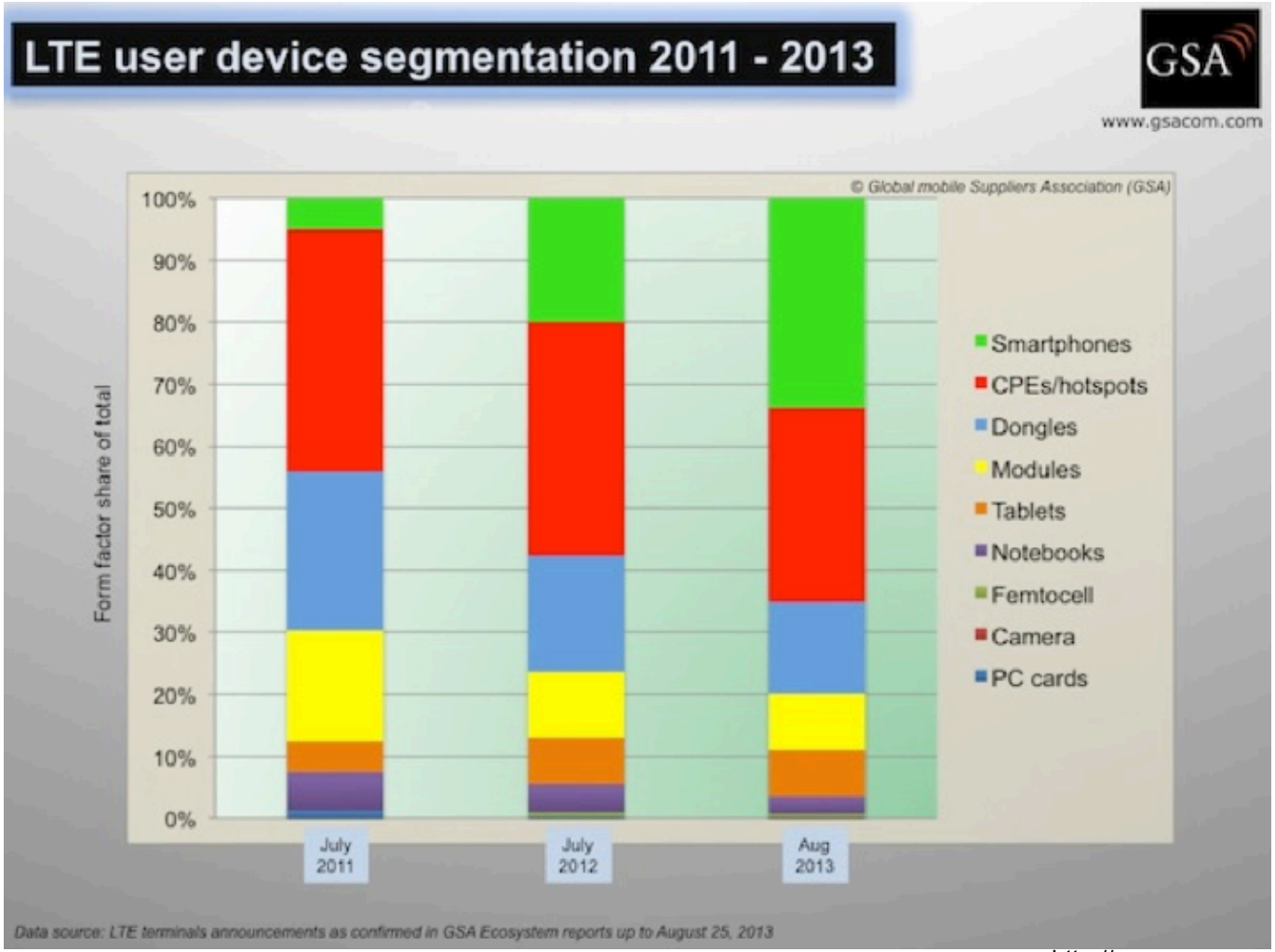
LTE user devices 2011 - 2013



http://www.gsacom.com/news/gsa_387.php

Rapidly increasing mobile devices

- The business competency of mobile network operators is shifting from being a traditional voice and messaging provider to a mobile broadband service provider
  - Services on voice, messaging, and data are converging on IP-based services
- Given the rapid increase in the number of mobile devices, rich media applications and content, investing in techniques just to extend the lifetime of IPv4 is ultimately limited from a business continuity point of view
  - IPv6 will sustain a future business model

IPv6 in mobile networks

- Significant growth in mobile devices accessing the Internet
  - Entry of mobile devices into the Internet is largely impacting the demography of Internet users and their behavior
  - Sustaining end-to-end connectivity will lead to innovative use of these tools
  - We have not seen the largest growth of the Internet yet!
  - And it's coming!!
- For example, Internet of Things, new applications using Machine-2-Machine (M2M) connectivity in areas of:
  - Energy and utilities, financial services and banking, government, healthcare, travel and transportation, etc.

IPv6 deployment: Where are we now?

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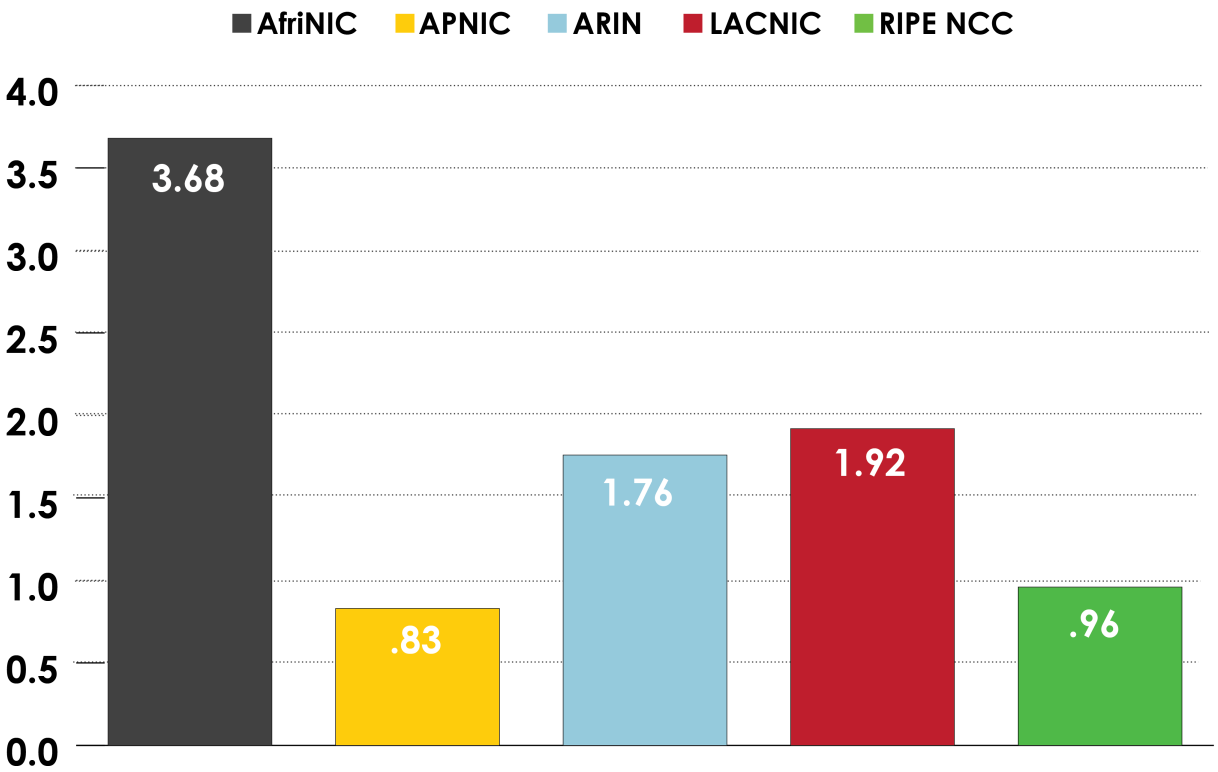
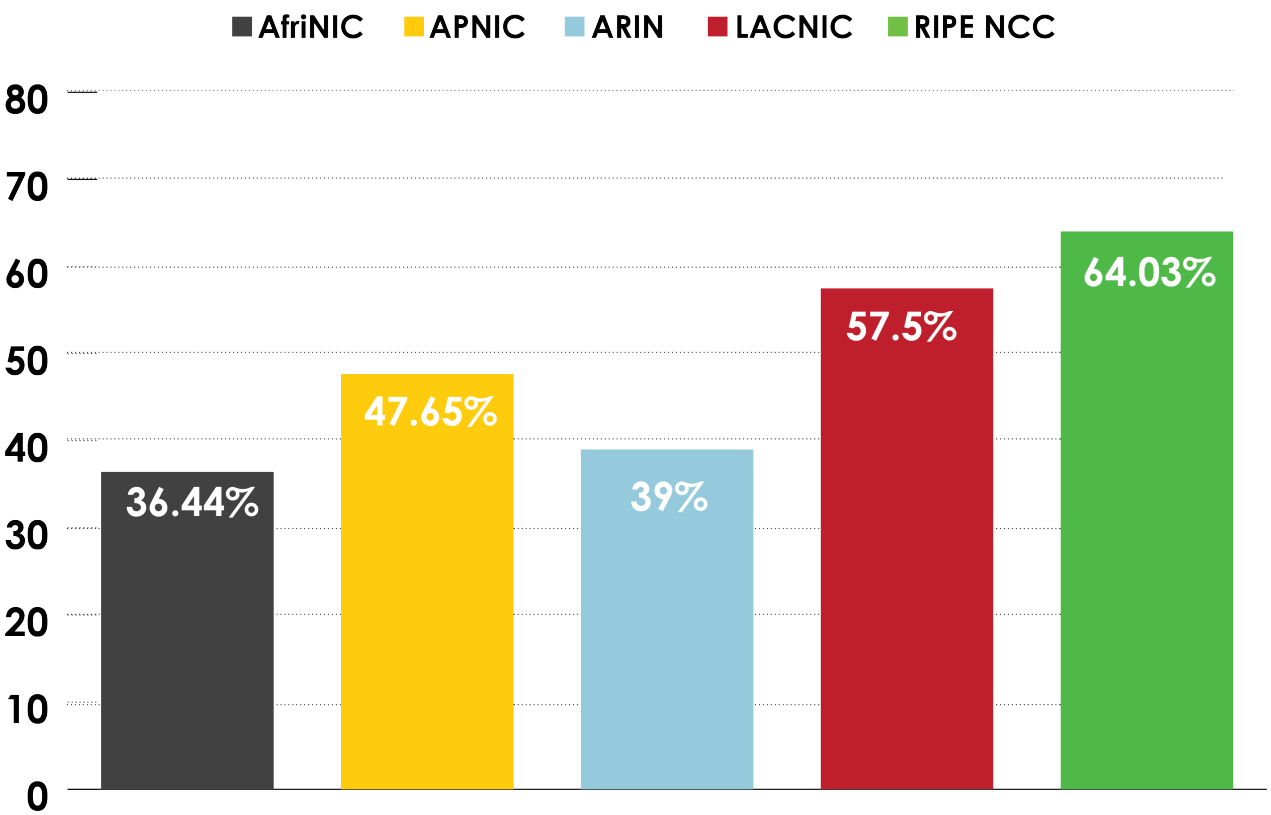
Remaining IPv4 address



NRO data: Oct 2013

http://www.nro.net/wp-content/uploads/NRO_Q3_2013.pdf Oct, 2013

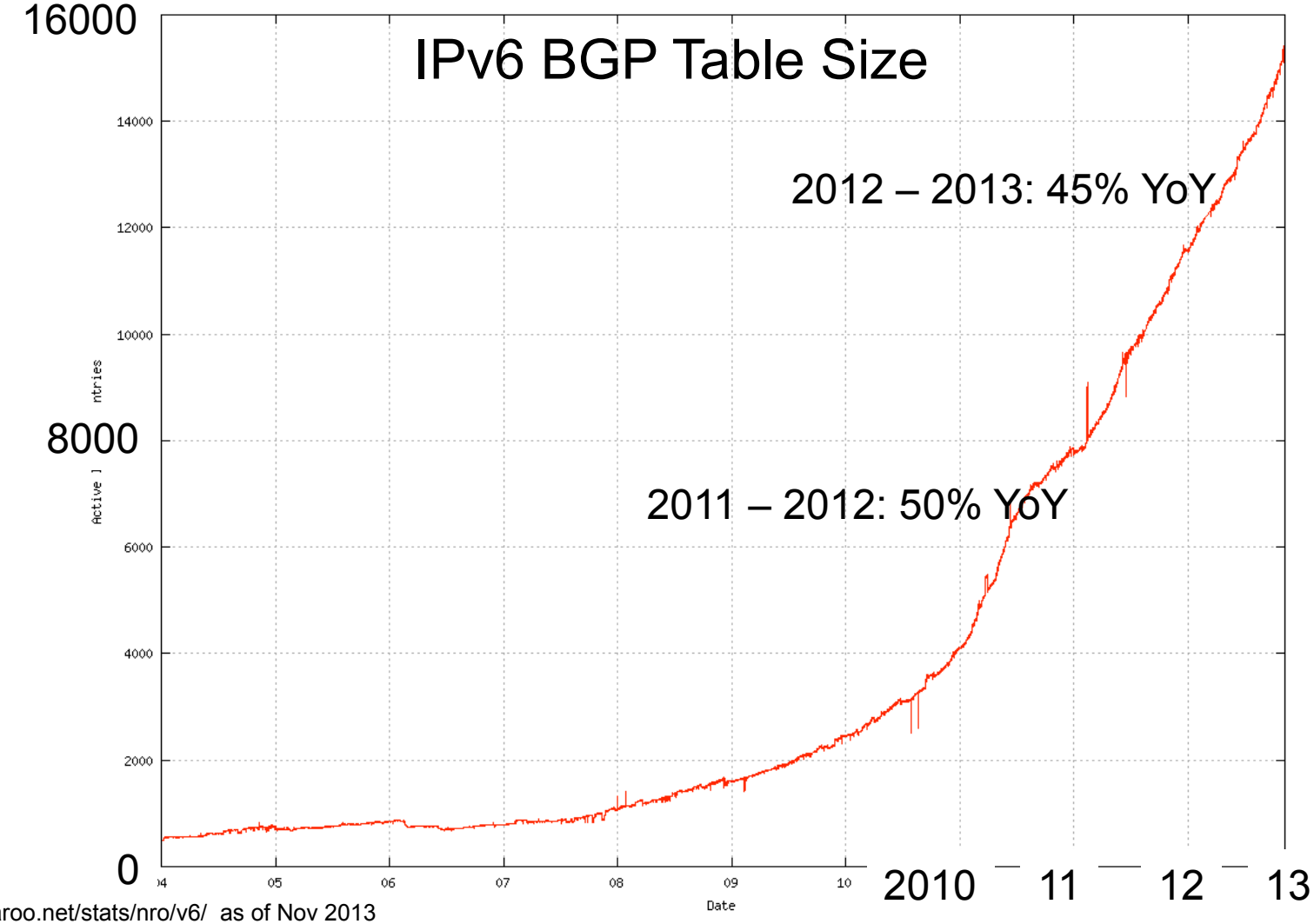
Percentage of members with both IPv4 and IPv6 in each RIR



NRO data: Oct 2013

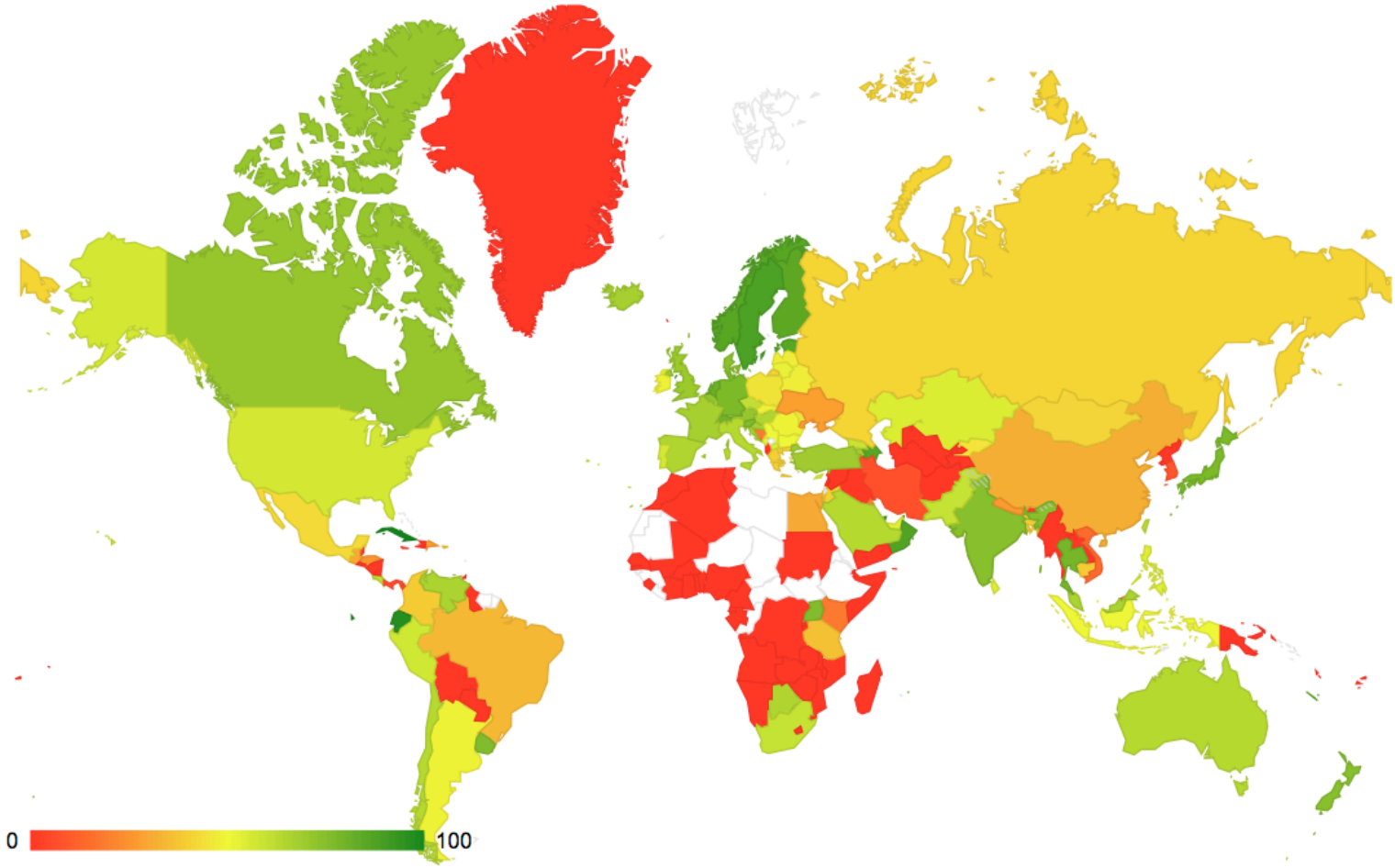
http://www.nro.net/wp-content/uploads/NRO_Q3_2013.pdf Oct, 2013

Network with IPv6



http://bgp.potaroo.net/stats/nro/v6/ as of Nov 2013

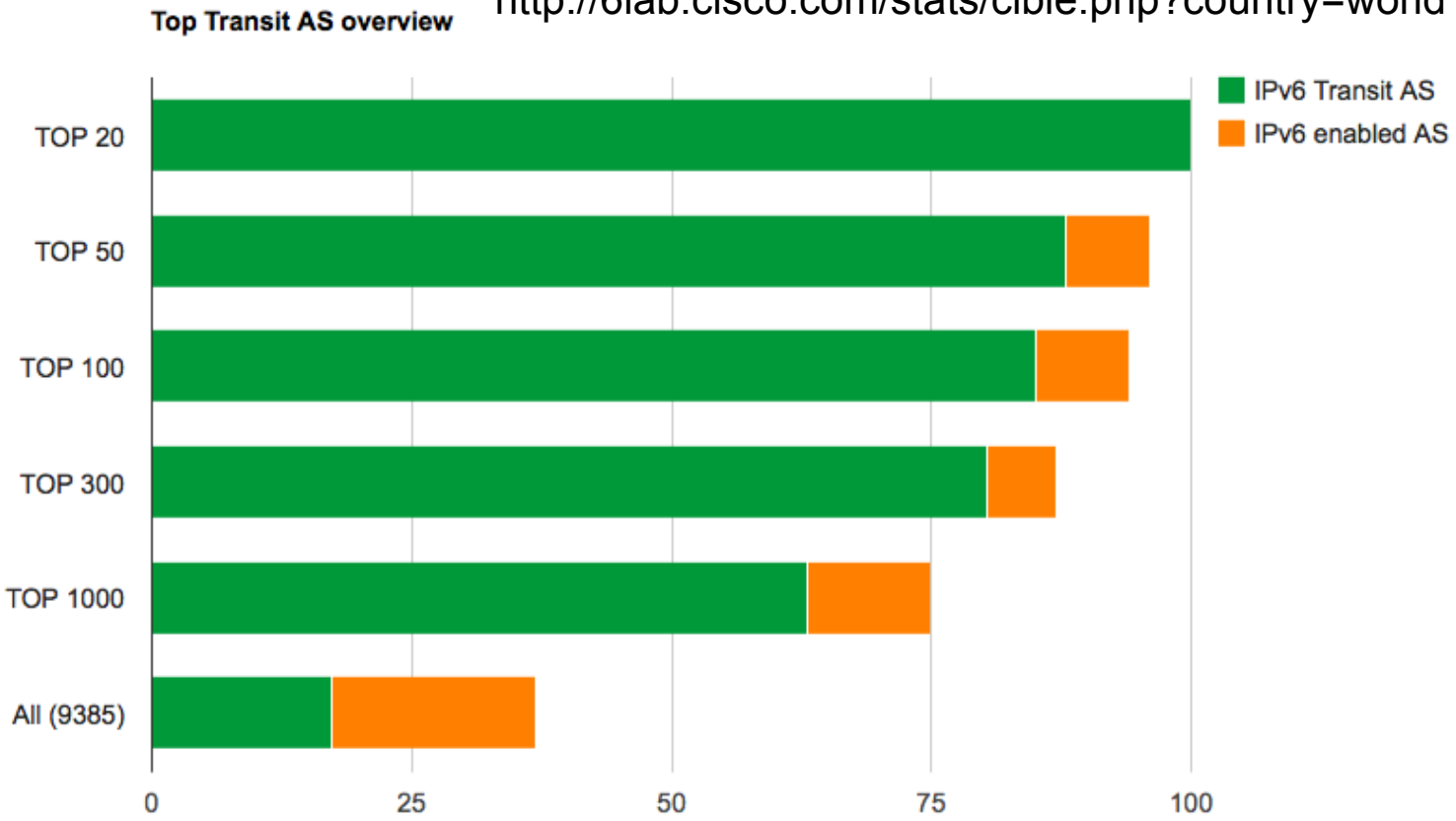
IPv6 transit AS
IPv6 readiness in core of the Internet



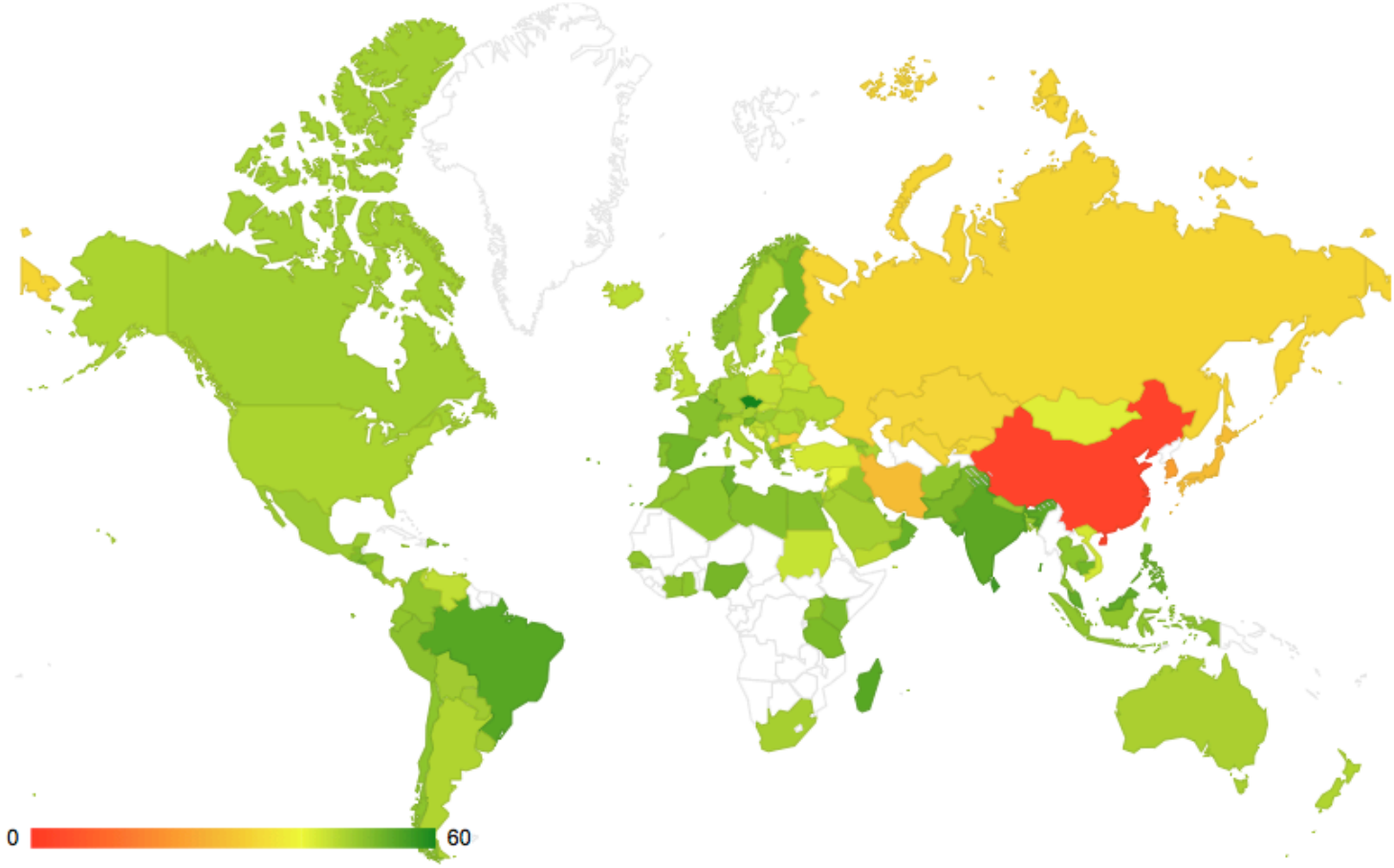
http://6lab.cisco.com/stats/index.php

IPv6 adoption in Internet core networks

http://6lab.cisco.com/stats/cible.php?country=world



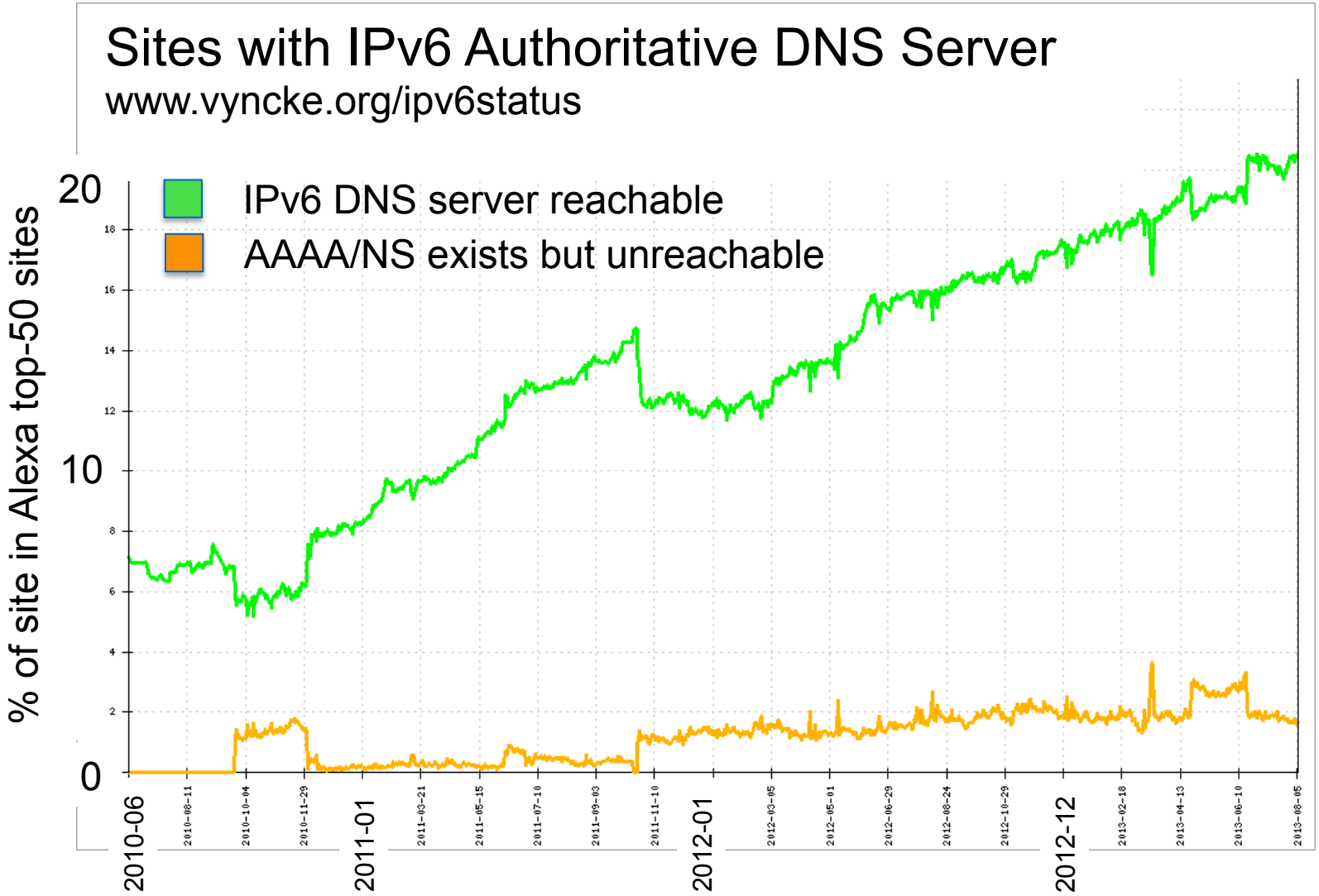
World ranking
IPv6 ready web sites



Alexa top 500 website / economy

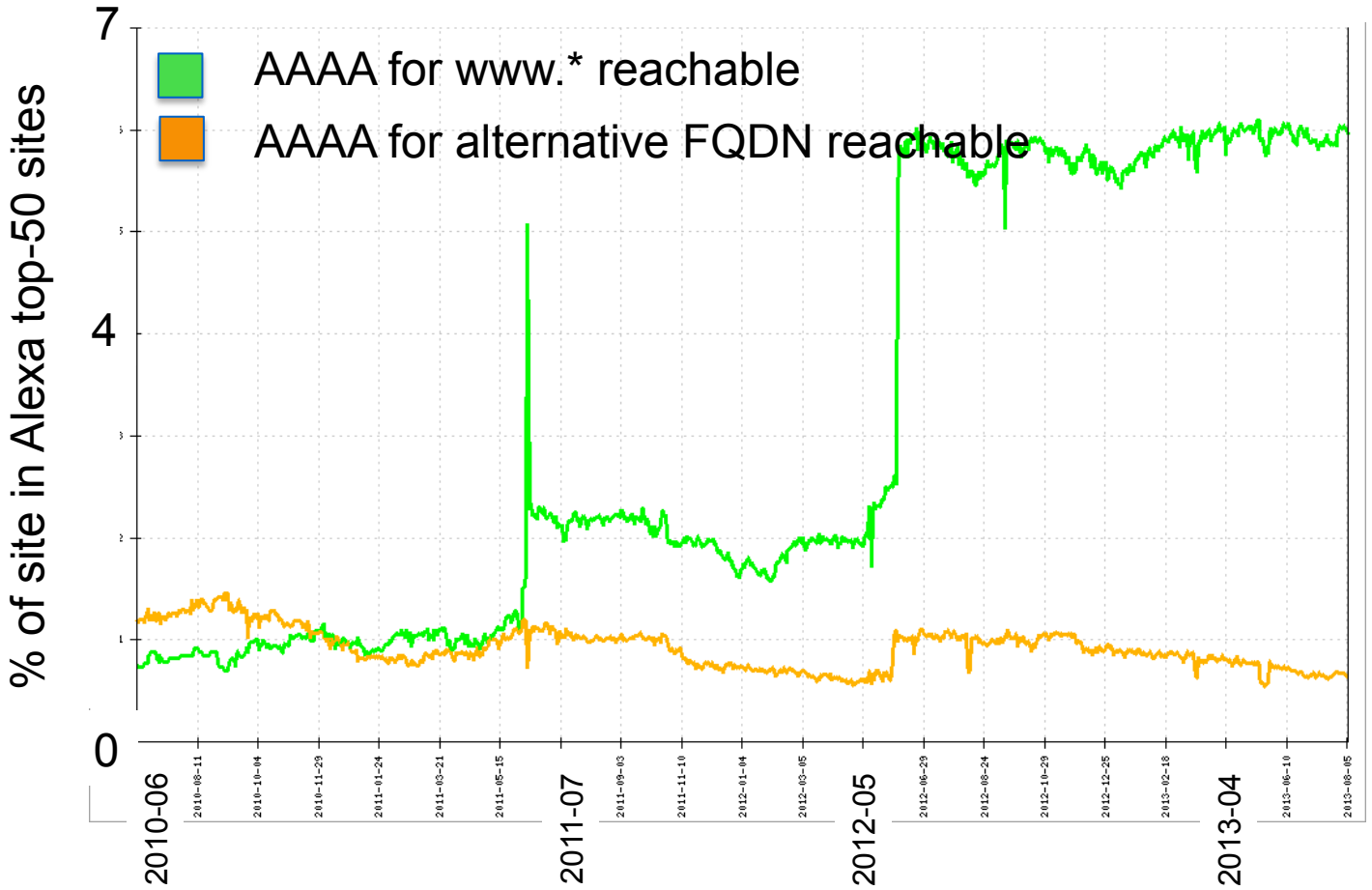
http://6lab.cisco.com/stats/index.php

IPv6 enabled DNS servers

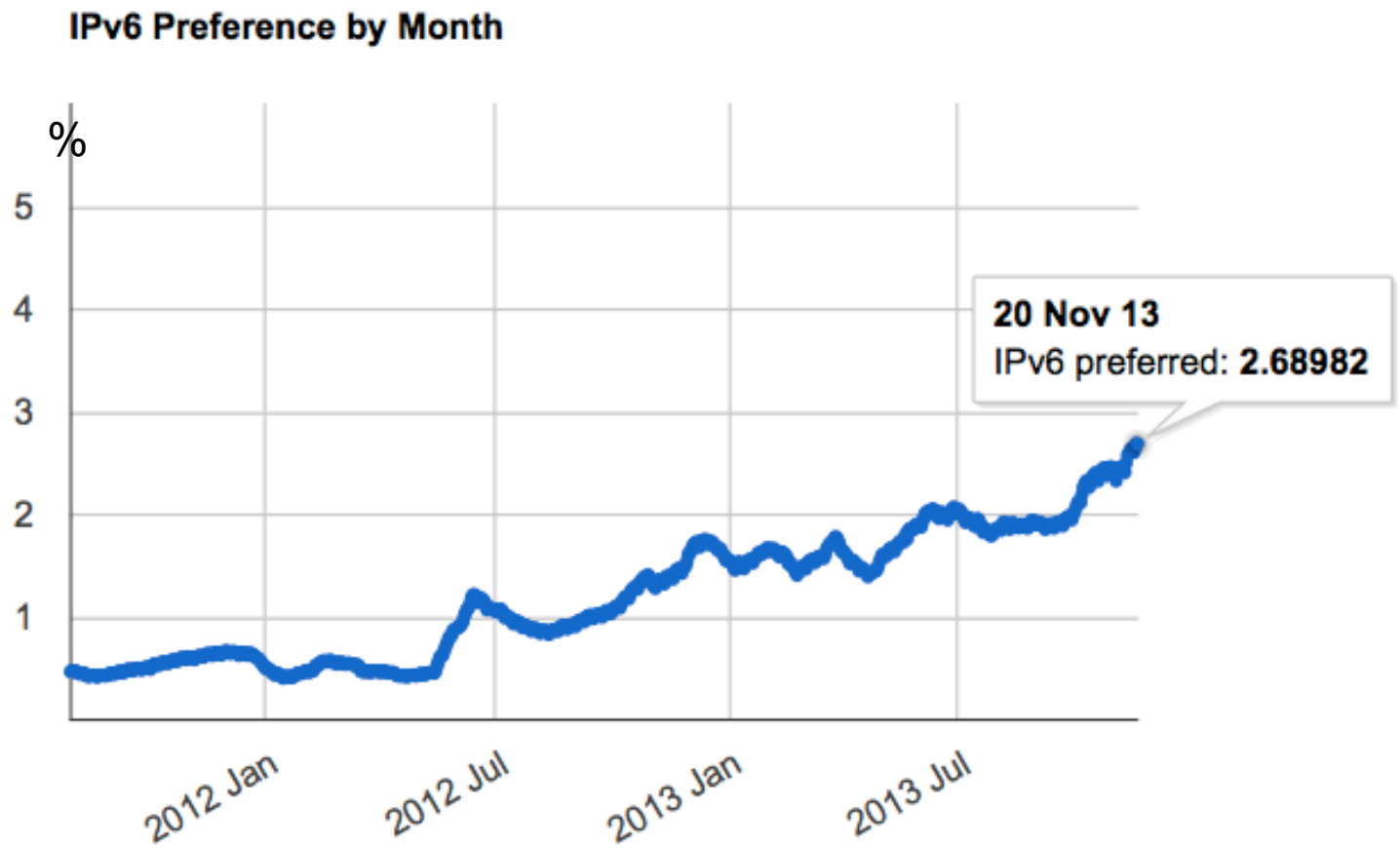


IPv6 enabled www sites

www.vyncke.org/ipv6status



IPv6 measurement
End user readiness: World



Data source from “flash” and “JavaScript”
and including viewers from mobile devices

http://labs.apnic.net/ipv6-measurement/Regions/001%20World/ as of 29/09/2013

IPv6 measurement
End user readiness: World rankings

IPv6 measurements by Economy.

http://labs.apnic.net/ipv6-measurement/Economies/

World rankings by IPv6 Preference

Economy	v6pref	3month avg hits/month	*notes*
CH	11.01%	6814	
RO	9.32%	231408	
LU	8.98%	1524	
EU	6.71%	348	
FR	5.76%	249152	
JP	4.56%	267630	
BE	4.48%	36126	
DE	4.01%	50249	
PE	3.71%	84584	
US	3.32%	429950	
SG	2.20%	12463	
CZ	1.63%	45160	

IPv6 deployment leaderboard in the world

ASN	Entity	Economy	IPv6 preferred rate
22394	Cellco Verizon Wireless	US	38.46
2516	KDDI KDDI CORPORATION	JP	29.17
18126	CTCX Chubu Telecommunications Company; Inc.	JP	28.43
8708	RCS-RDS SA	RO	23.38
3303	Swisscom	CH	22.20
4739	INTERNODE-AS Internode Pty Ltd	AU	14.34
7922	Comcast	US	12.16
4773	MOBILEONELTD-AS-AP MobileOne Ltd. Mobile/ Internet Service Provider Singapore	SG	9.90
23655	SNAP-NZ-AS Snap Internet Limited	NZ	8.72
55430	STARHUBINTERNET-AS-NGNBN Starhub Internet Pte Ltd	SG	8.53

http://labs.apnic.net/ipv6-measurement/AS/ 09/10/2013

Observation

- IPv6 deployment status is varied among regions, economies and individual ASN (network operators)
  - IPv6 deployment is not happening all at once
  - Some economies have been very active in terms of IPv6 deployment
  - Some ASNs have been very active in terms of IPv6
- See more details in
  - http://labs.apnic.net
  - http://www.apnic.net/community/ipv6-program/data

IPv6 deployment status in Brunei

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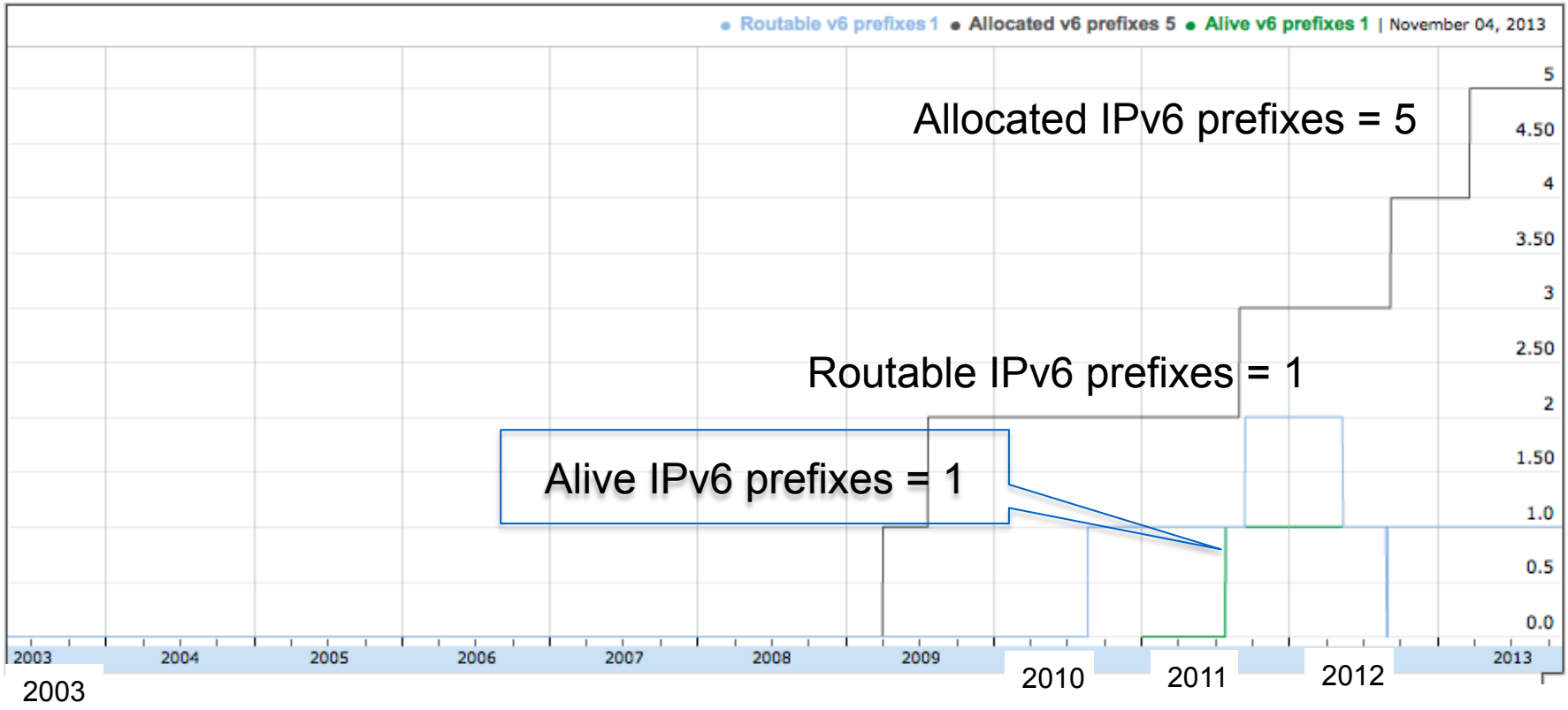
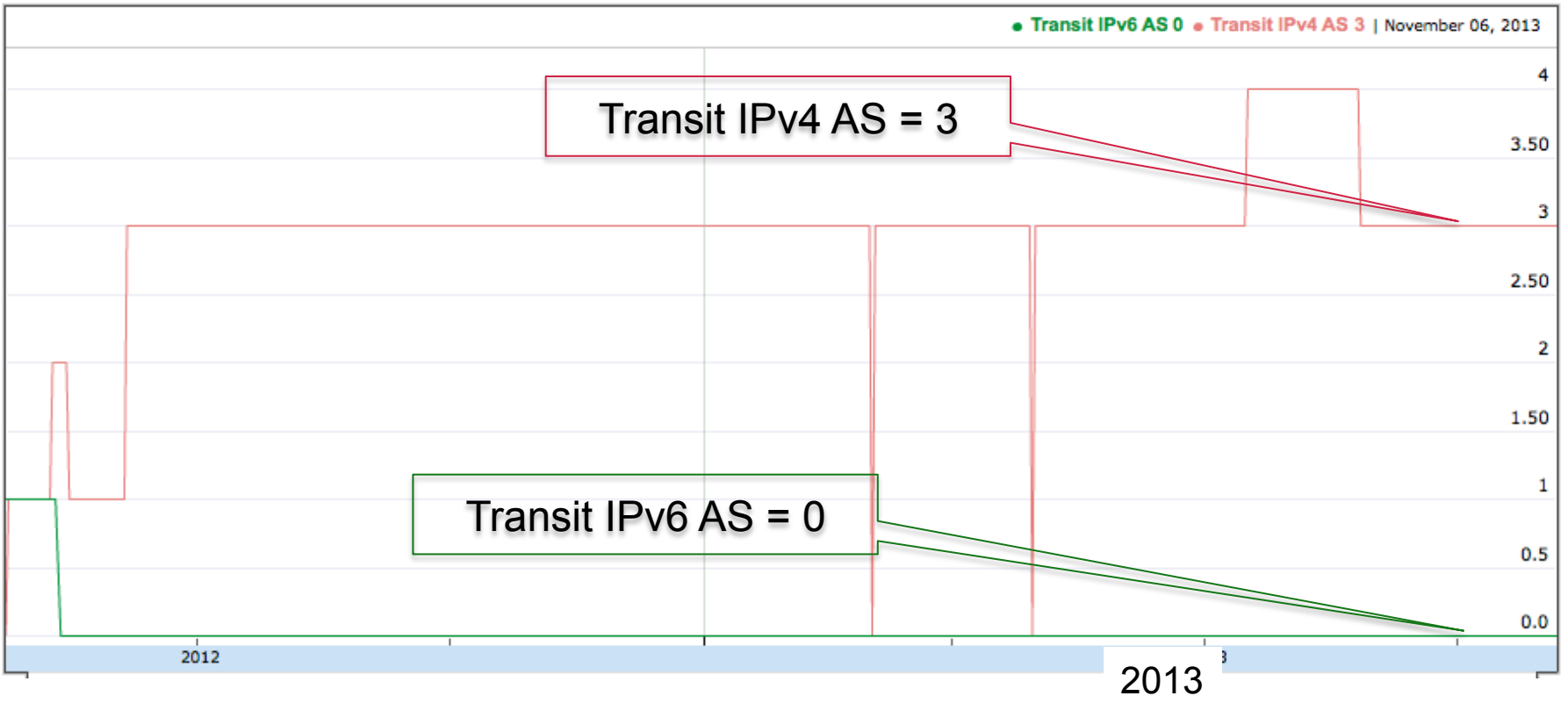
IPv6 prefix data in Brunei



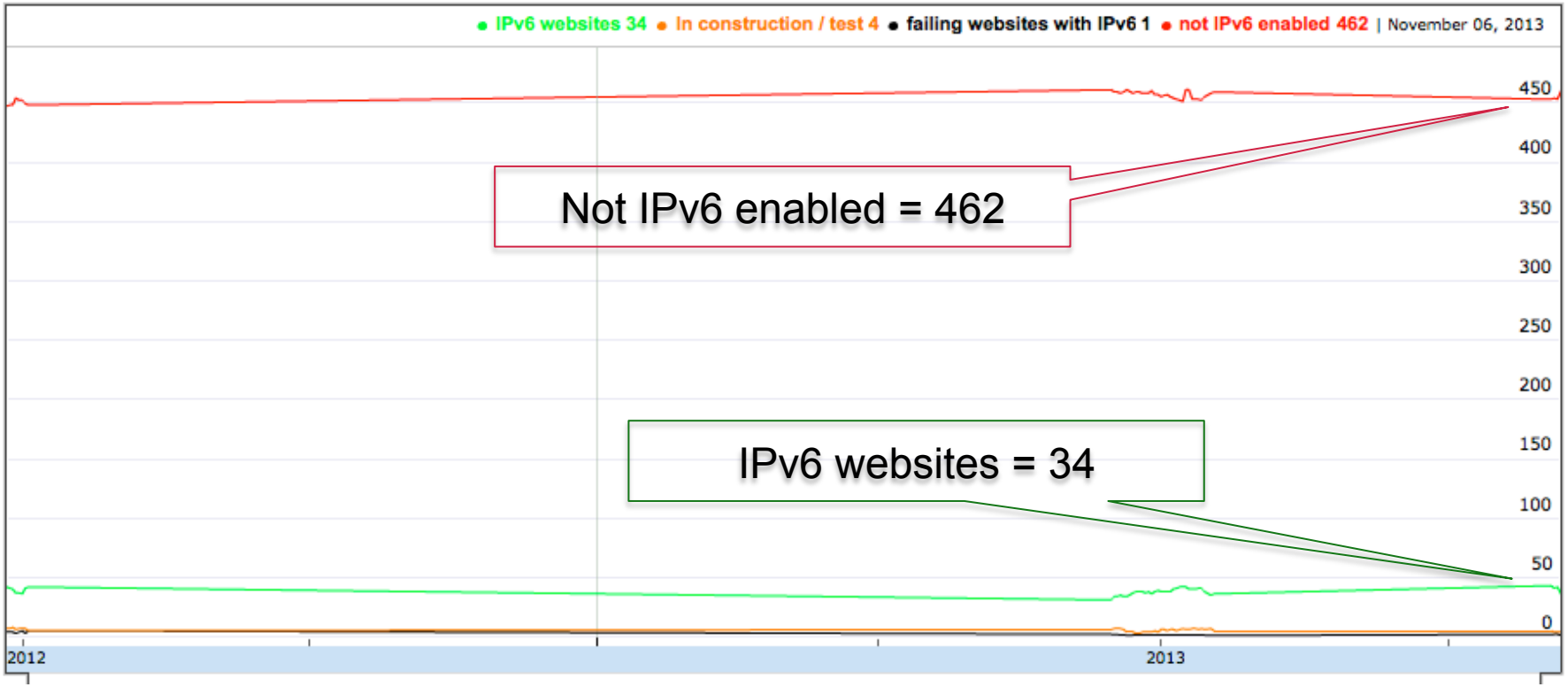
http://6lab.cisco.com/stats/cible.php?country=BN as of 04/11/2013

IPv6 enabled transit providers in Brunei



http://6lab.cisco.com/stats/cible.php?country=BNas of 06/11//2013

IPv6 enabled content in Brunei



2013

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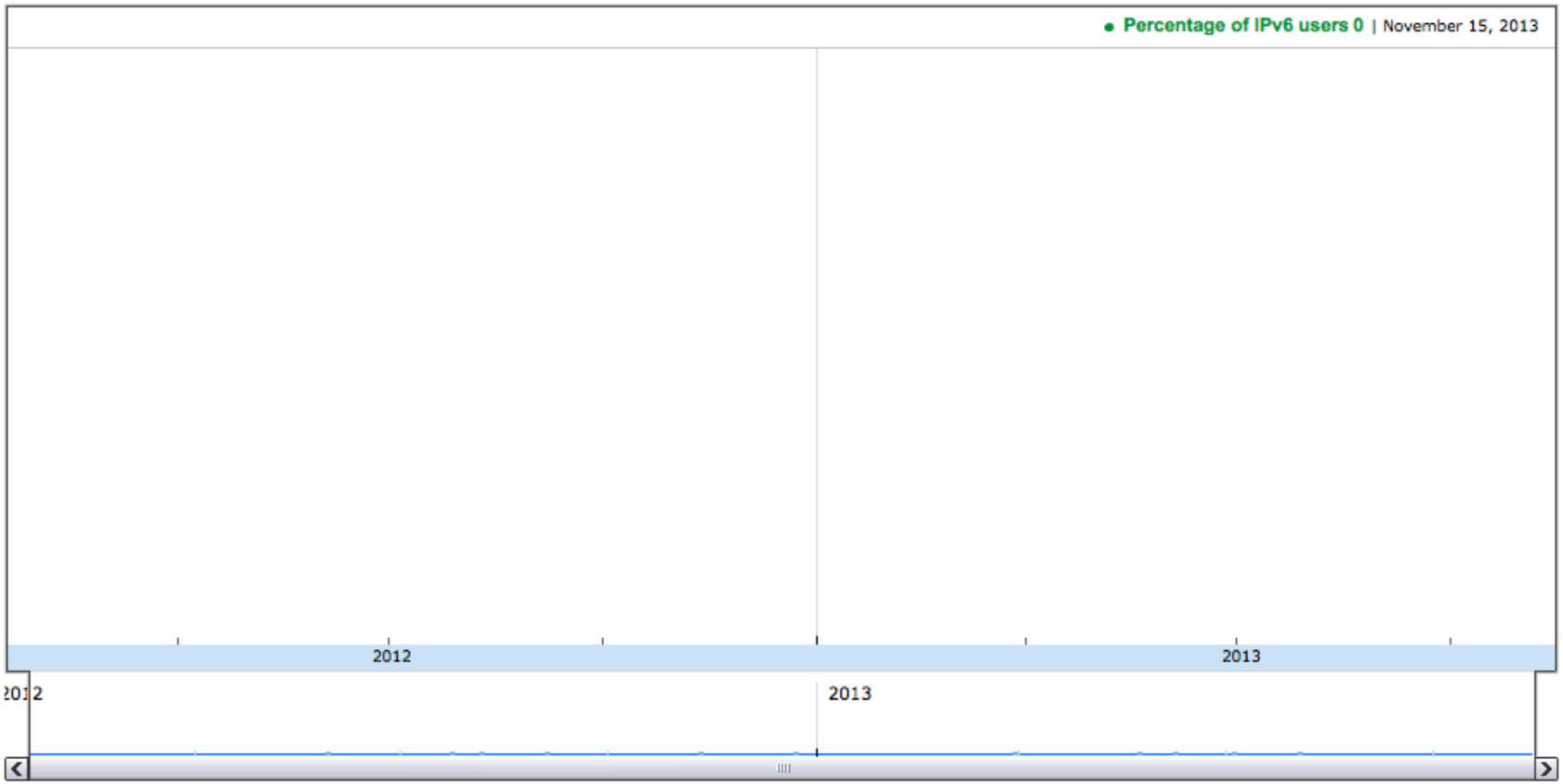
IPv6 measurement
End user readiness: Brunei



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Observations
IPv6 deployment in Brunei

- Transit networks, providers need to get ready with IPv6 capability in their core.
- End user deployment is always going to be challenging
  - Due to CPE upgrade costs, customer-provisioning costs
- Other economies appear to be facing similar problems
  - But some ISPs are also biting the bullet.
  - CTC, KDDI, Internode, MobileOne, Starhub, RCS, Comcast
- IPv6 capability to be explored
  - More IPv6 implementation in the last mile is required in Brunei to grow the base of end users that have access to IPv6 enabled Internet resources via IPv6 enabled access and core networks

Anecdotal story 1

Akamai

APNIC

IPv6 deployment @AKAMAI

IPv6 is live in	June 2012	June 2013
Countries	53	64
Cities	175	240
Networks	225	300
Akamai server locations	600	800
Akamai servers	37,000	70,000

Total of 1100+ networks in 83 countries

http://conference.apnic.net/data/36/20130826-apnic-2013_13775025031.pdf

IPv6 deployment @AKAMAI

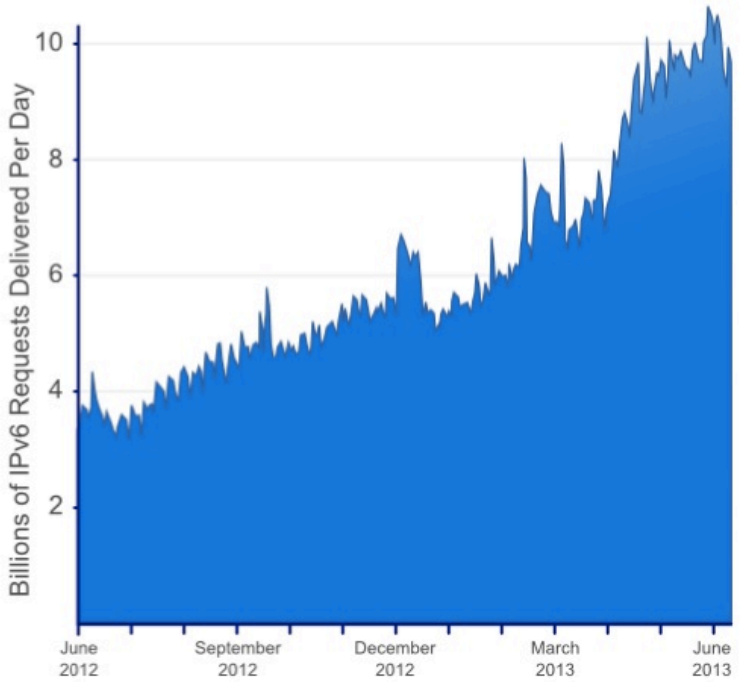
World IPv6 Launch Anniversary: A closer look from Akamai

IPv6 Addresses

- 2011: 280,229
- 2012: 18,899,253
- ***67x***
- 2013: 200m – 300m
- ***10x***

IPv6 Requests/Day

- 2011: 8,343,590
- 2012: 3,394,971,156
- ***460x***
- 2013: >10 billions
- ***2.5x***



IPv6 Requests/Day on Akamai from June 2012 to June 2013

http://conference.apnic.net/data/36/20130826-apnic-2013_13775025031.pdf

IPv6 growth path @AKAMAI

World IPv6 Launch Anniversary: IPv6 and Mobile

Akamai

Mobile Operating System	IPv6 as % of Requests
Windows Phone OS 8	12%
BlackBerry OS 10	5.9%
Android 4.1/4.2 ("JellyBean")	10.8%
Android 4.0 ("Ice Cream Sandwich")	3.2%
Android 2.3 ("Gingerbread")	1.6%
Apple iOS 6	1.8%
Apple iOS 5	1.4%
Apple iOS 3/4	1.1%

- using Akamai's Mobile Browser Detection for categorization
- Within Android, there are individual device types where well over 50% of the traffic to dual-stacked websites arrived over IPv6.

http://conference.apnic.net/data/36/20130826-apnic-2013_13775025031.pdf

IPv6 growth path @AKAMAI

World IPv6 Launch Anniversary: IPv6 and Desktop/Laptop Operating Systems

Operating System	Browser	IPv6 as % of Requests
Microsoft Windows 8		4.1%
Microsoft Windows Vista		3.3%
Microsoft Windows 7		2.5%
Microsoft Windows XP		0.5%
Mac OS X 10.5 & 10.6	Chrome & Firefox	3.4%
Mac OS X 10.5 & 10.6	Safari	3.3%
Mac OS X 10.7 & 10.8	Chrome & Firefox	3.3%
Mac OS X 10.7 & 10.8	Safari	2.1%

- Happy Eyeballs

http://conference.apnic.net/data/36/20130826-apnic-2013_13775025031.pdf

What AKAMAI sees

World IPv6 Launch Anniversary:
Three drivers of IPv6 growth

1. Content availability
   - Customers opting in to have their sites, content, and applications permanently available dual-stacked.
2. Availability of IPv6 from access network providers
   - IPv6 in production networks, e.g. Verizon Wireless, AT&T, and Comcast.
   - Some ISPs, Universities and Research Labs in Europe and Asia that have had IPv6 deployed
3. End-user device support
   - Recent desktop and laptop OS and client software supports IPv6
   - Many home routers / gateways start to support IPv6 recently.
   - 4G LTE smart phones.

http://conference.apnic.net/data/36/20130826-apnic-2013_13775025031.pdf

Anecdotal story 2

Chubu Telecommunications Co., Inc.

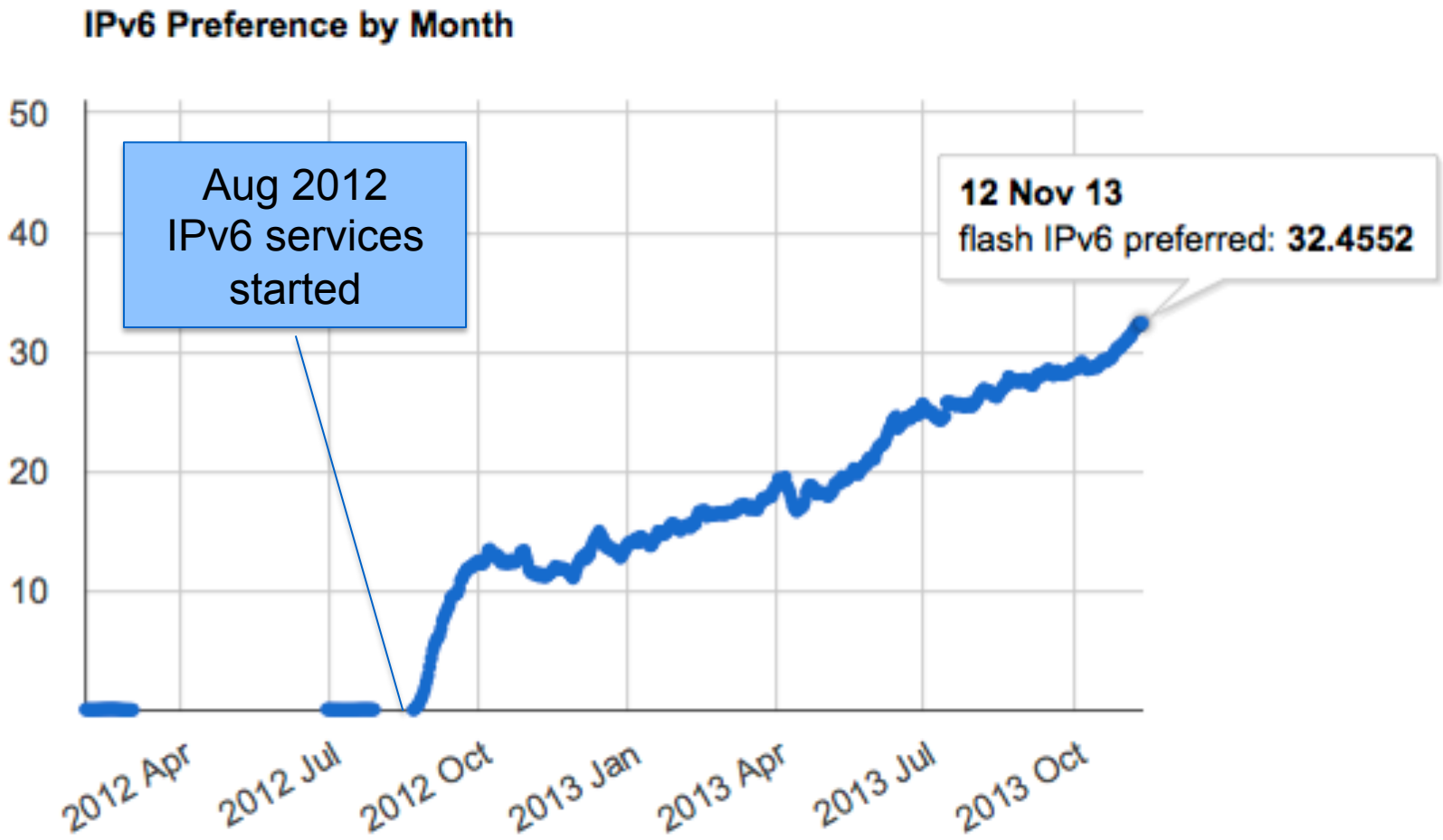
APNIC

IPv6 deployment @CTC

- CTC: a regional ISP in Japan
  - About 600,000 subscribers
  - Services: High-speed Internet access, VoIP and TV
- Mar 2010: Started research on how to deploy IPv6
- Mar 2011: Started IPv6 Deployment Project
  - Customers should be able to automatically access to the Internet either via IPv4/IPv6 without caring about IPv4/IPv6 connectivity
- Aug 2012: Started delivering IPv6 access service on their FTTH Internet access services
- And today…

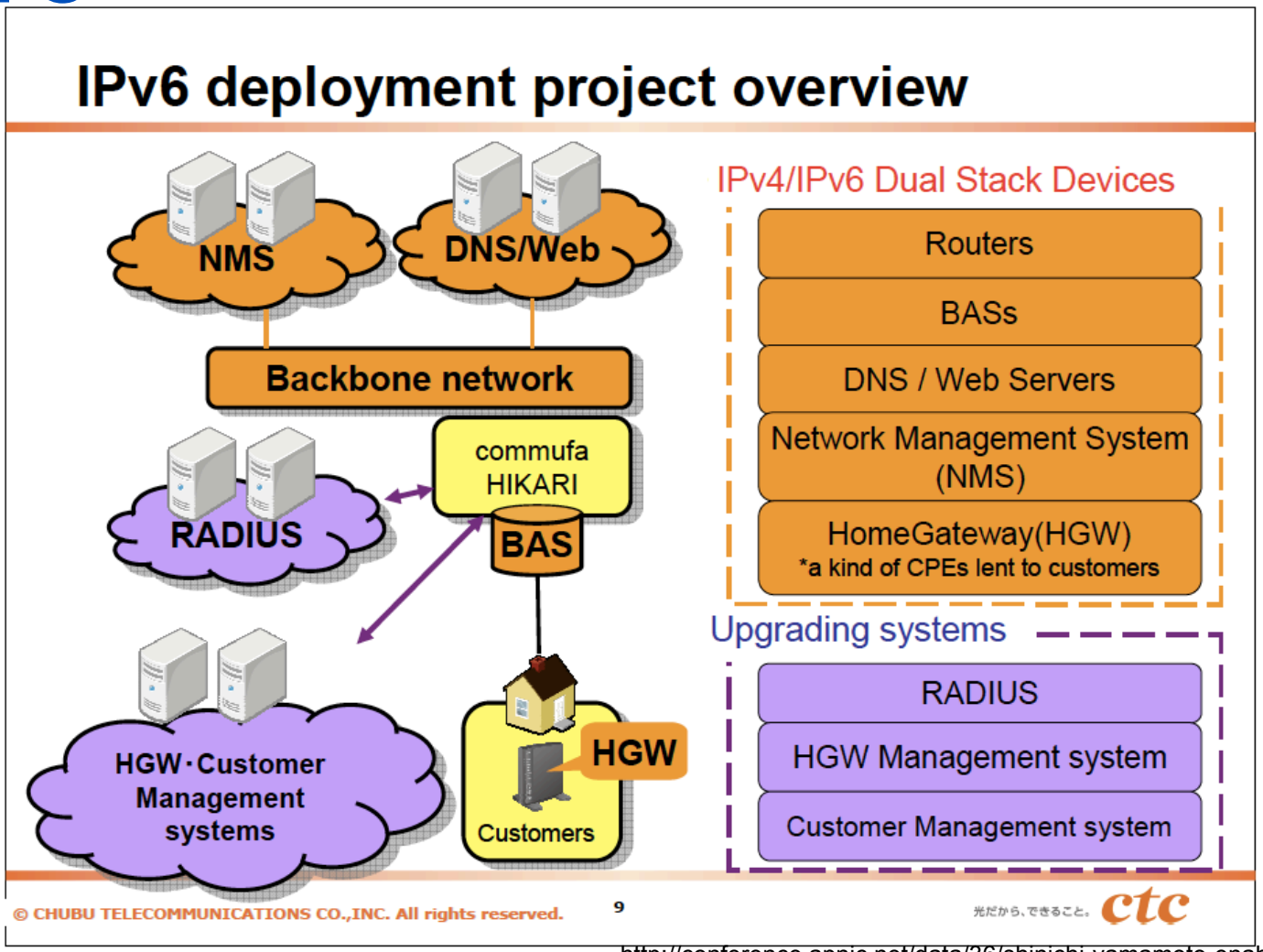
http://conference.apnic.net/data/36/shinichi-yamamoto-enabling-ipv6-on-ftth.pdf

IPv6 deployment @CTC



http://labs.apnic.net/ipv6-measurement/AS/1/8/1/2/6/ as of 15/11/2013

Overview: IPv6 Deployment Project @CTC



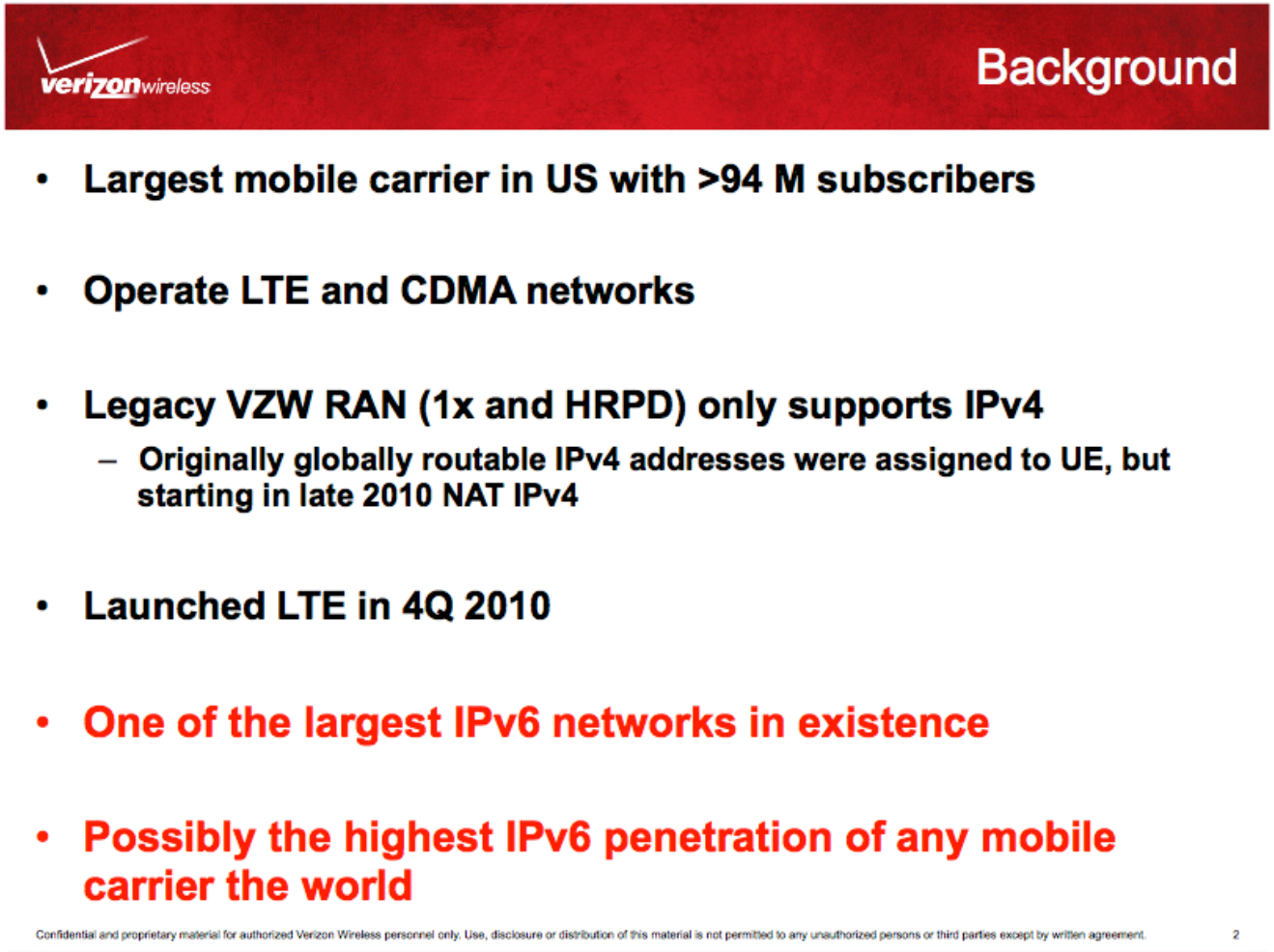
http://conference.apnic.net/data/36/shinichi-yamamoto-enabling-ipv6-on-ftth.pdf

Anecdotal story 3

Verizon Wireless (VZW)

APNIC

IPv6 deployment @VZW



http://conference.apnic.net/__data/assets/pdf_file/0017/50813/vzw_apnic_13462152832-2.pdf

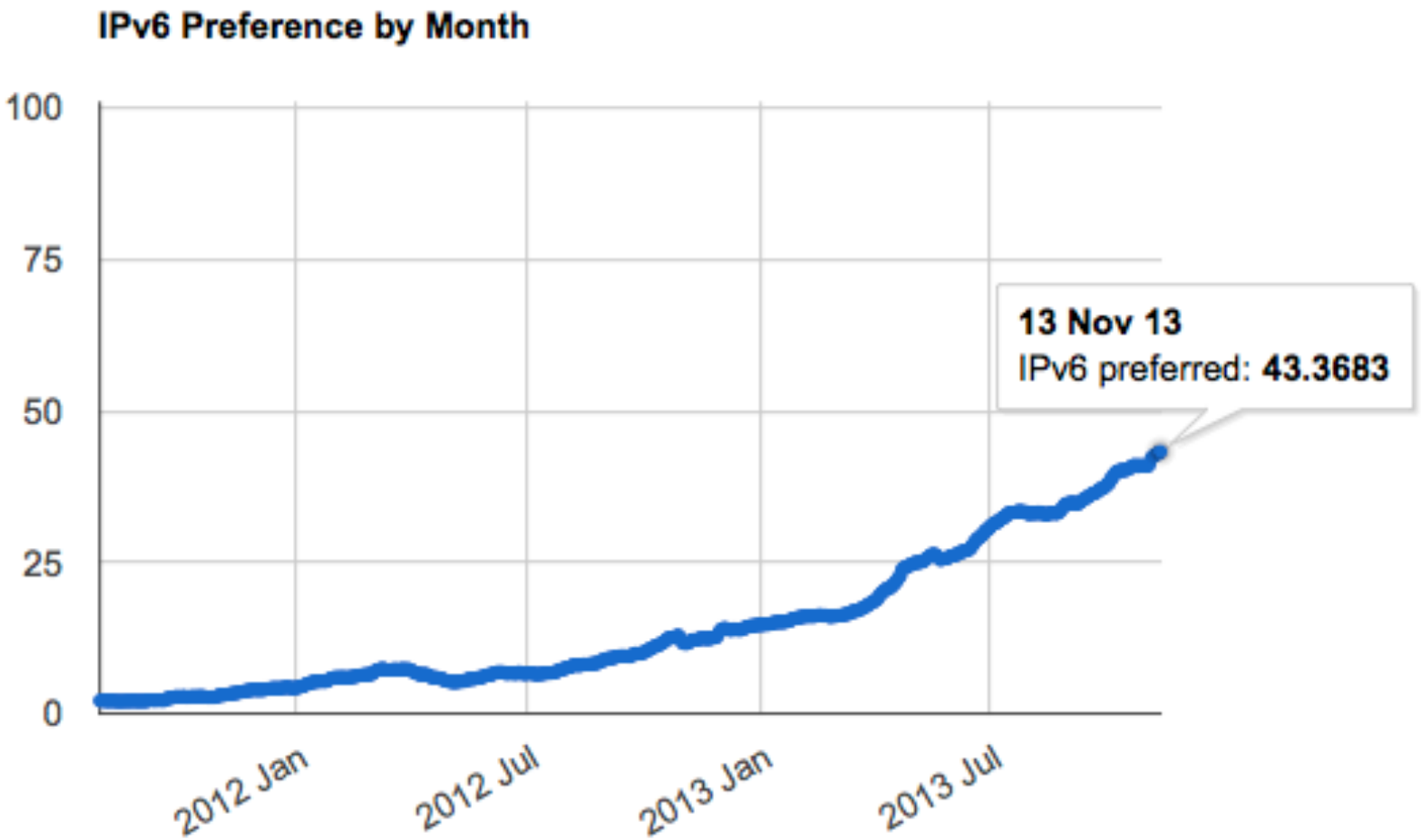
IPv6 deployment @VZW

- **VZW recognized that IPv6 was a necessity not something "optional"**
  - **Built the network regardless of IPv6 enabled content**
- **IPv4 address exhaustion**
  - **Issue exasperated by modern "always-on" smartphones**
  - **Workaround : CGN**
- **IPv4 NAT problematic in certain situations**
  - **Certain apps / protocols have issues working with NAT**
  - **Prolongs the move to IPv6**
  - **IP based auth does not work**

 3

http://conference.apnic.net/__data/assets/pdf_file/0017/50813/vzw_apnic_13462152832-2.pdf

IPv6 deployment @VZW Today



http://labs.apnic.net/ipv6-measurement/AS/2/2/3/9/4/ as of 15/11/2013

Governments' initiative in the AP region

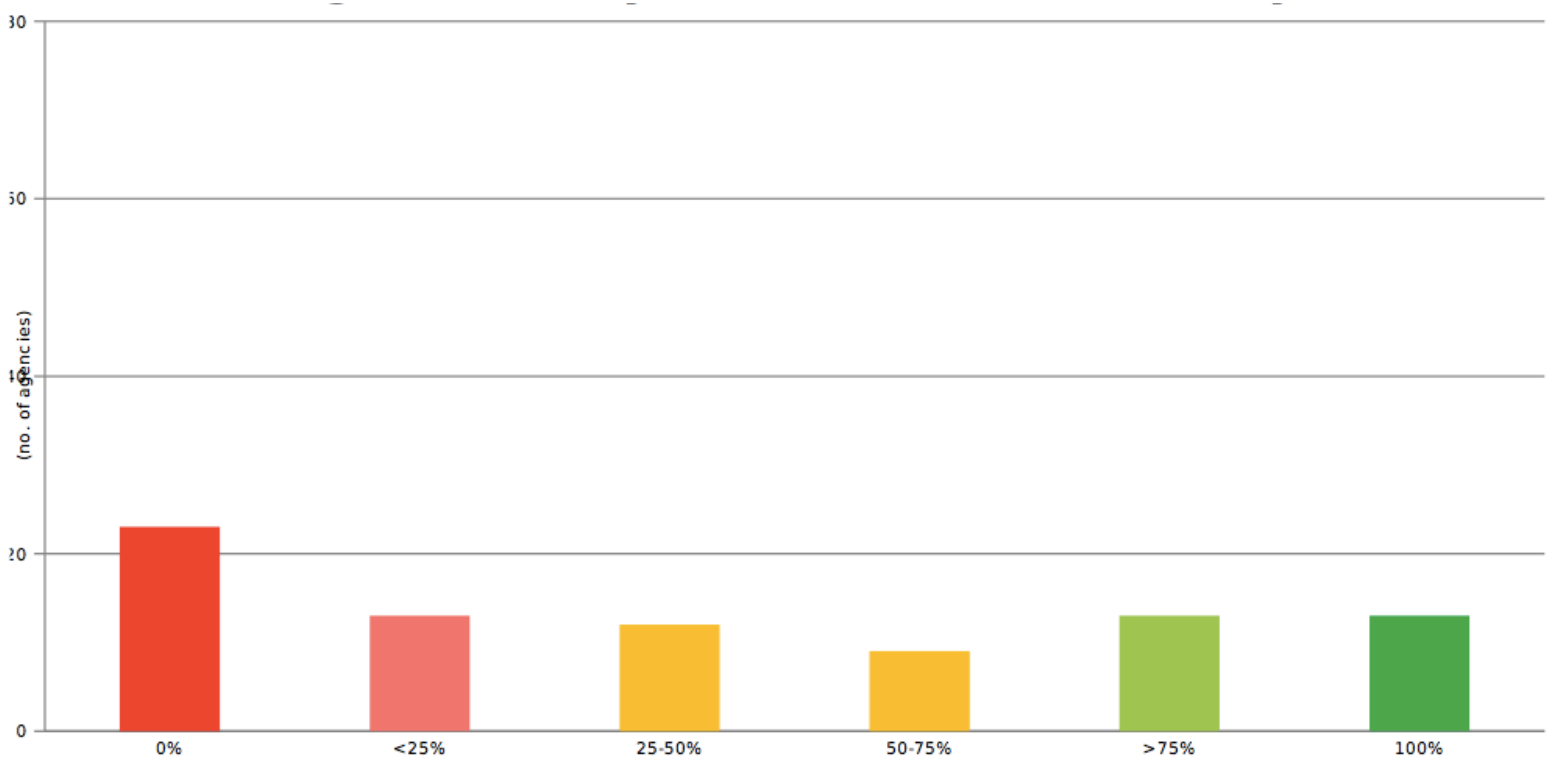
APNIC

Australia

- A Strategy for the Implementation of IPv6 in Australian Government Agencies
  - Version 1 in 2007, Version 2 in 2009
  - All government agencies should have IPv6 capable hardware and software platforms by 2012
  - To operate dual stack IPv4 and IPv6 environment by 2015
    - Stage 1: Preparation (Jan 2008 – Dec 2009)
    - Stage 2: Transition (Jan 2010 – Dec 2011)
    - Stage 3: Implementation (Jan 2012 – Dec 2012)
- Internode: IPv6 commercial service is available since 2008
  - About 14% of end users can access IPv6 networks and resouces
- Telstra: IPv6 commercial service for enterprises since 2011

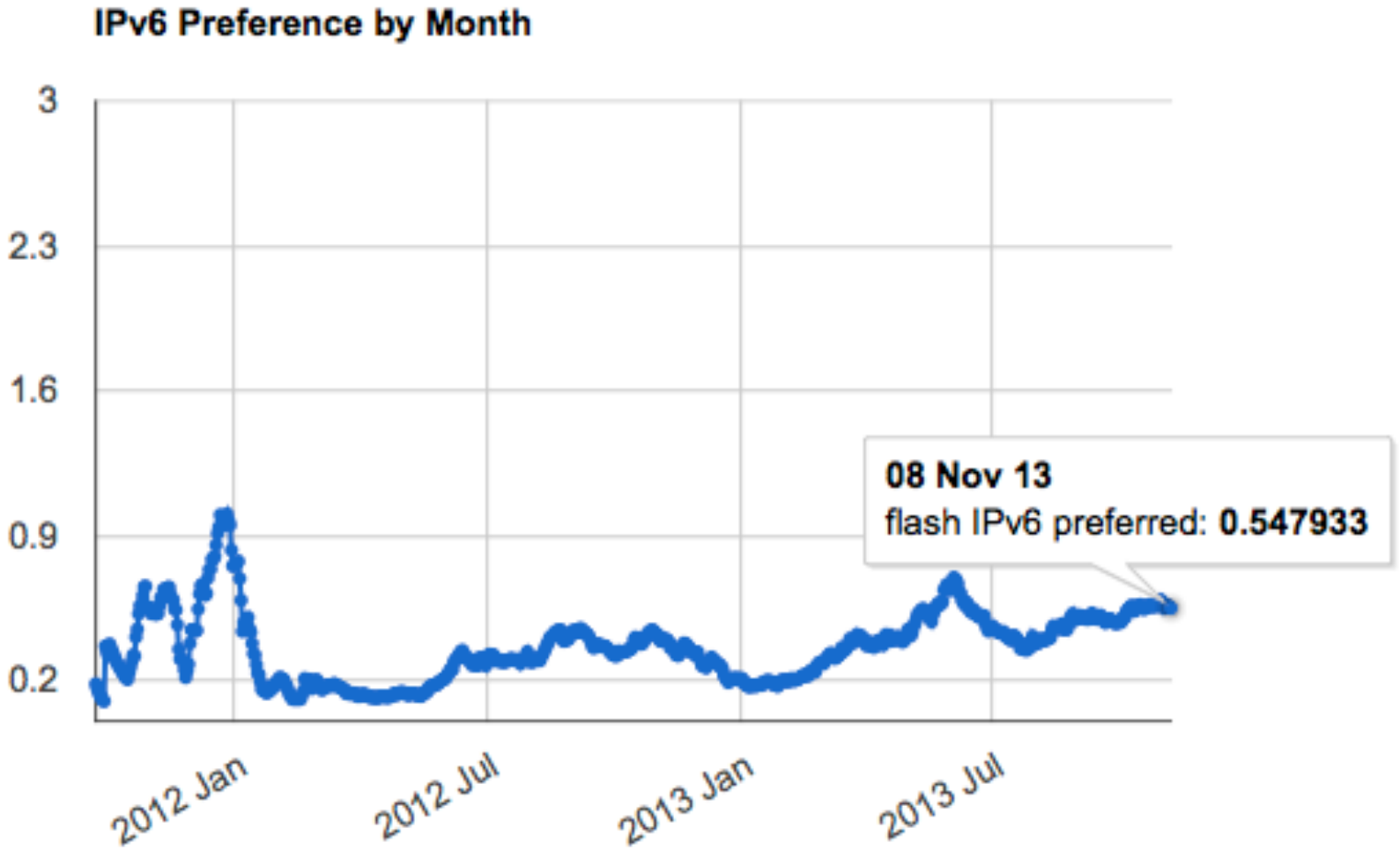
Australia: Stats

- Reported update on the current Stage 3 implementation level (as of 2012) reported by AGIMO



http://www.ipv6.org.au/summit/talks/JohnHillier_AGIMO_IPv6Summit12.pdf

Australia: Stats



http://labs.apnic.net/ipv6-measurement/Economies/AU/

China

- Announcement made by the Chinese State Council in Nov 2011
  - IPv6 mandates to the Industry
    - "China will put Internet Protocol version 6 (IPv6) into small-scale commercial pilot use and form a mature business model by the end of 2013, the State Council recently said at an executive meeting about the main goals and road map for the China Next Generation Internet project" (People's Daily Online, Jan 2012, http://english.people.com.cn/90778/7696495.html)
    - 3 million users for each operators by 2013
    - 25 million users by 2015
  - SPs in China are responding to this mandate
    - "IPv6 Deployment Experience in China Telecom" (@APNIC36, Aug 2013)
      - http://conference.apnic.net/data/36/0828ipv6-deployment-experience-in-ctv4_13770491941.pdf
      - More than 3 mil IPv6 subscribers by the end of 2013, more than 8mil by the end of 2015
    - IPv6 Progress in China Mobile (@APNIC34, Aug 2012)
      - http://conference.apnic.net/__data/assets/pdf_file/0007/50668/ipv6-progress-in-china-mobile-20120829_1345773579.pdf
      - Starting IPv6 commercial service 2014 - 2015

China

中国互联网络信息中心
CHINA INTERNET NETWORK INFORMATION CENTER

IPv6 Plan of e-Government Extranet

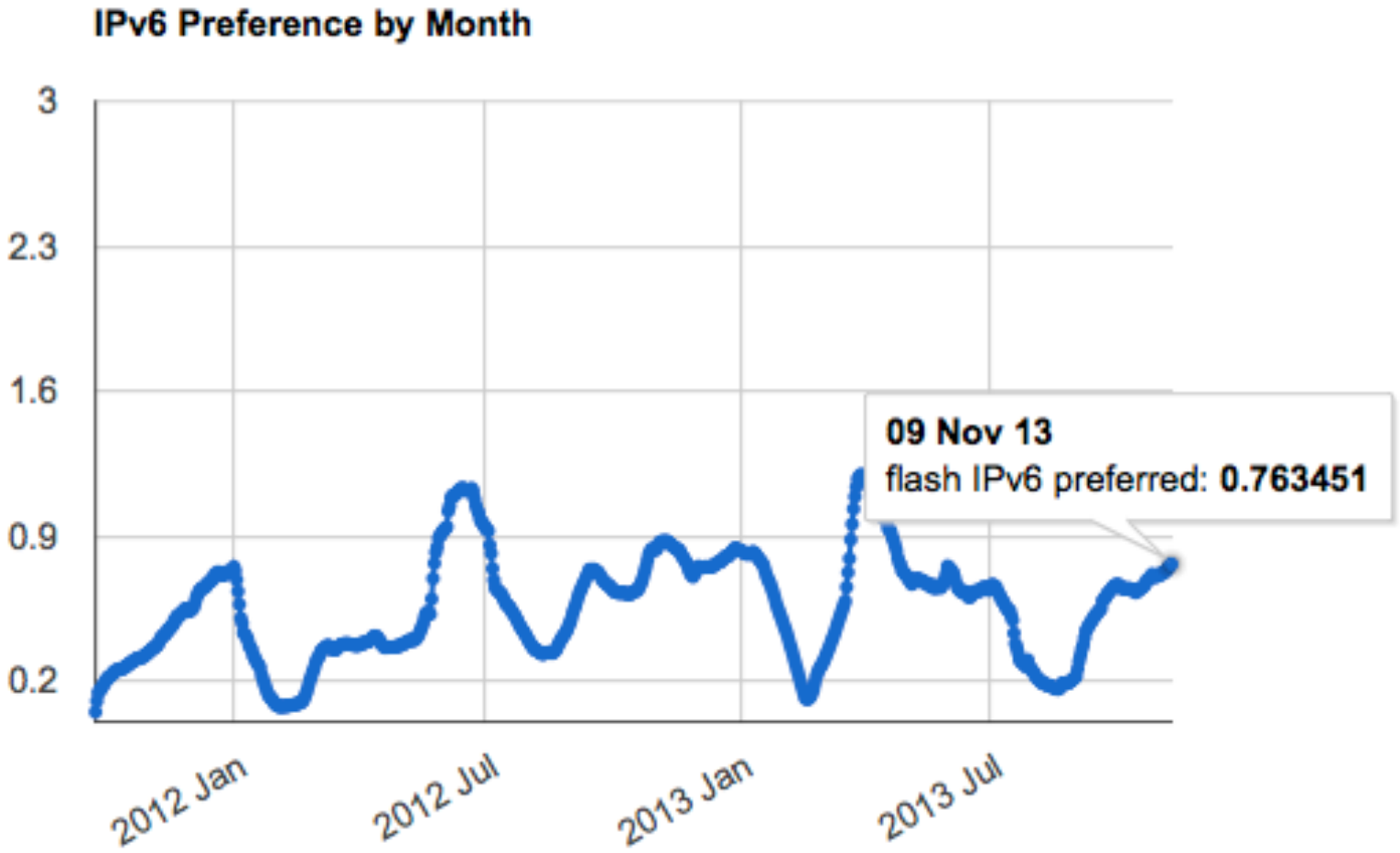
■Chinese authorities pay great attention on the Next Generation Internet based on IPv6 and have issued a series of announcements to specify the target and roadmap of development of next generation Internet, providing policy and financial supporting measures

■Following the important principle 'Government network must go first for the informatization', national e-government extranet (e-government public infrastructure) will take the lead in the field of e-government planning, deployment and pilot IPv6 related technologies

■IPv6 is a must for the e-government extranet, because with the expanding coverage of e-government network and increasing services& applications, IPv4 shortage is a big barrier for system deployment and providing new services

http://conference.apnic.net/data/36/cnnic-update_2013.8.27_1377563880.pdf

China: Stats



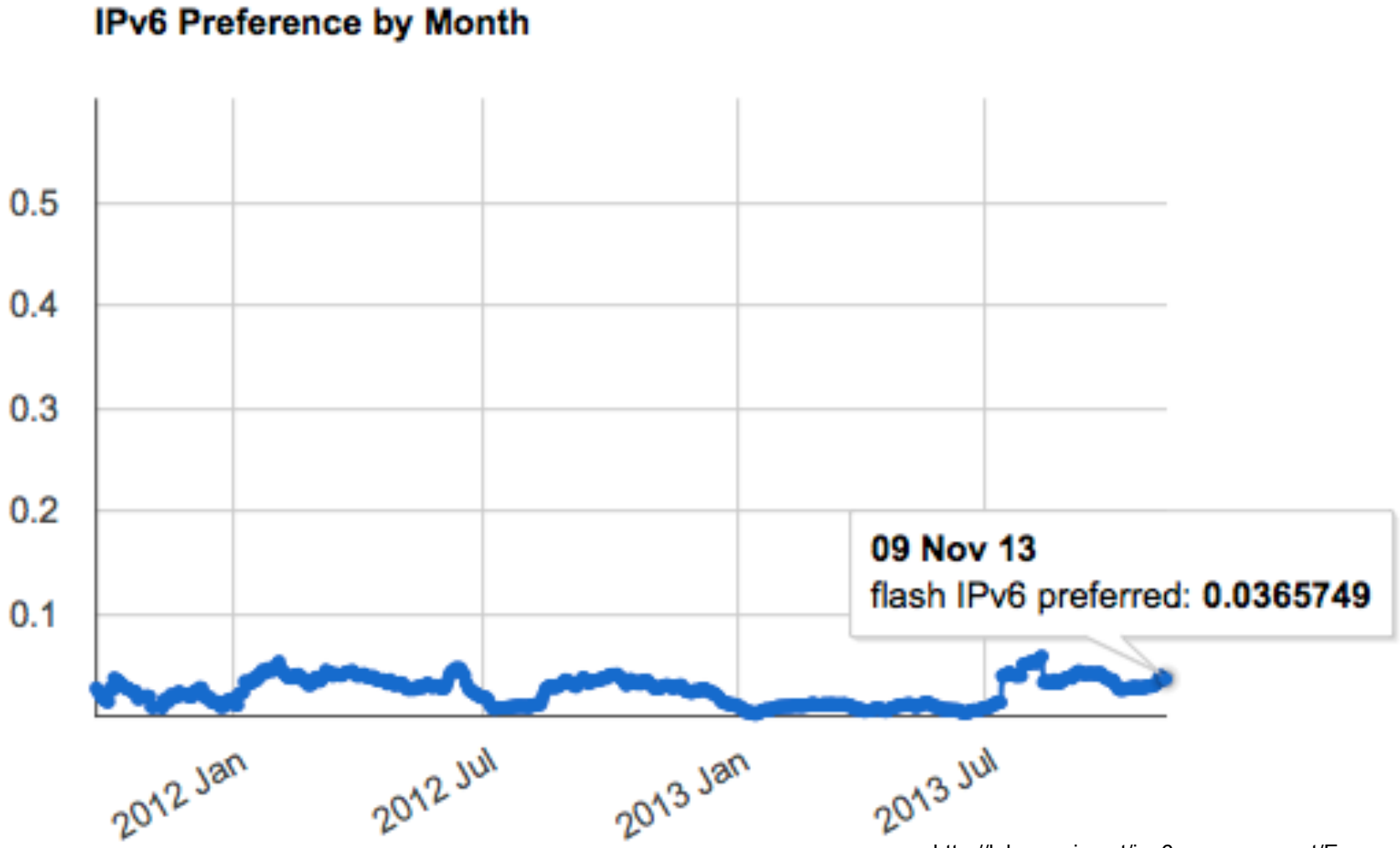
http://labs.apnic.net/ipv6-measurement/Economies/CN/

India

- National IPv6 deployment roadmap (version 2)
  - The original version was issued in June 2010
- Recommendations for Internet multi-stakeholders
  - Enable IPv6 services at all new enterprise customers (connecting to the Internet after Jan 2014)
  - Enable IPv6 services at all new retail wire line customers (connecting to the Internet after July 2014)
  - Enable IPv6 services for LTE customers (connecting to the Internet after June 2013)
  - All content and application providers to adopt iPv6 for new contents and applications by June 2014
  - All new .in domain to be compulsorily on dual stack from Jan 2014
  - All governments complete transition to IPv6 by Dec 2017

http://conference.apnic.net/__data/assets/pdf_file/0006/58533/DOT-PPT-APIPv6TF-Agarwal-ver2.pdf

India: Stats



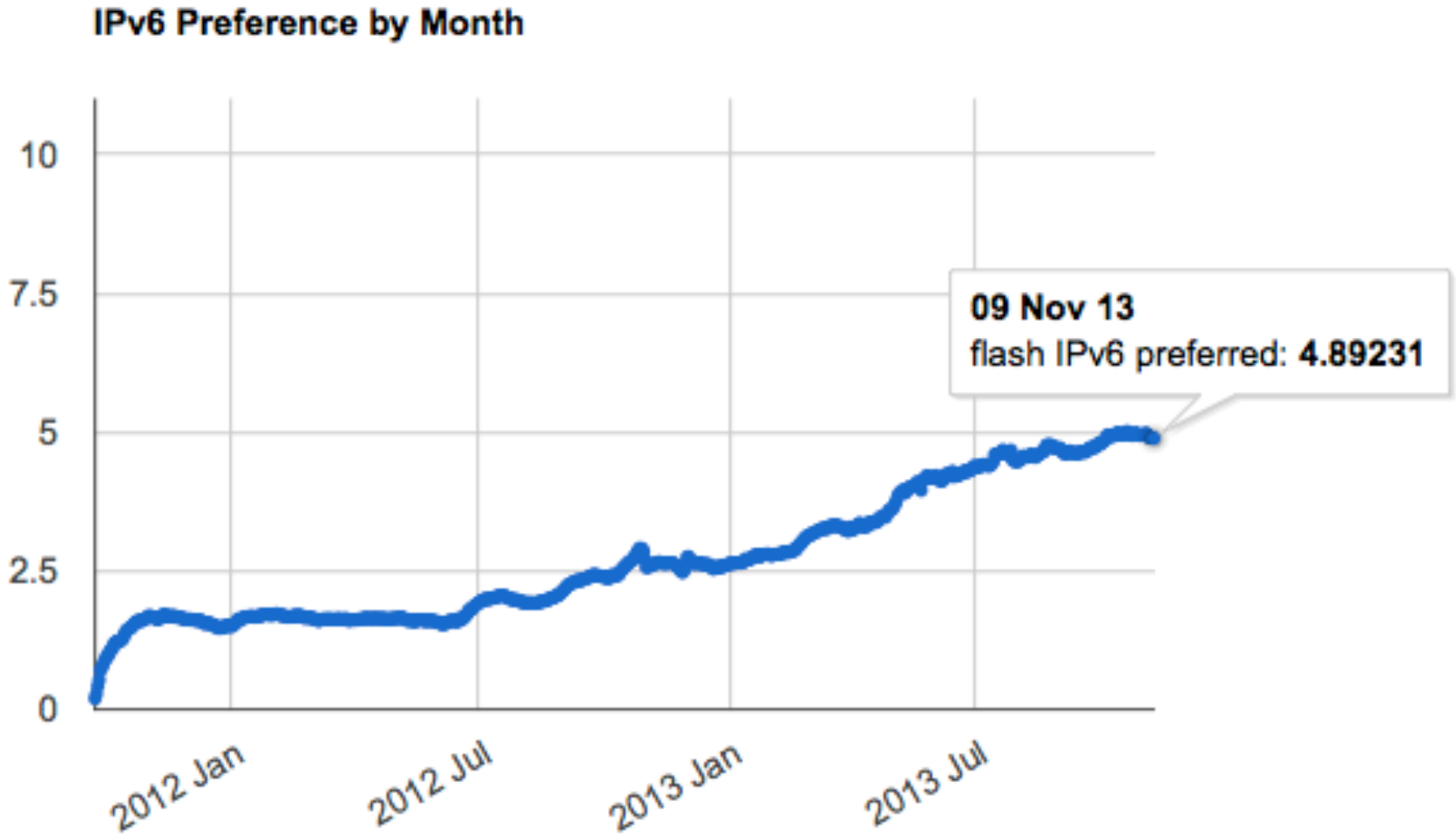
http://labs.apnic.net/ipv6-measurement/Economies/IN/

Japan

- Ministry of Internal Affairs and Communications conducts regular IPv6 Study Group
  - Partnership between the public and private sectors
    - Detailed field level discussions
  - Most recent one on July 2013
    - Active discussion on CGN: concerns on its relatively high costs, possible negative impact to end users
    - Update on usage of existing IPv6 test bed (APs and CPs)
    - Discussion on potential formats of IPv6 service deliveries: Default IPv6 services
      - Some providers are experiencing positive result
    - Discussion on IPv6 services in mobile networks
    - Discussion on developing IPv6 security guidelines

http://www.soumu.go.jp/main_sosiki/joho_tsusin/policyreports/chousa/ipv6_internet/02kiban04_03000222.html

Japan: Stats



http://labs.apnic.net/ipv6-measurement/Economies/JP/

Korea

- IPv6 interconnection agreement among ISPs in Korea
  - Wired network: 3 major ISPS (KT, SKB, LGU+) adopted IPv6 at their backbone and IXs (Dec 2012)
- Mobile network: A joint project of Korea Internet & Security Agency (KISA) and SK Telecom (Number one mobile network operator in Korea) to test IPv6 on LTE mobile network (Dec 2012)
  - Android devices on NAT64 successfully worked
  - http://www.youtube.com/watch?v=wYzN0c7go4M
  - IPv6 traffic monitoring and billing system etc. need to be prepared before commercializing the service

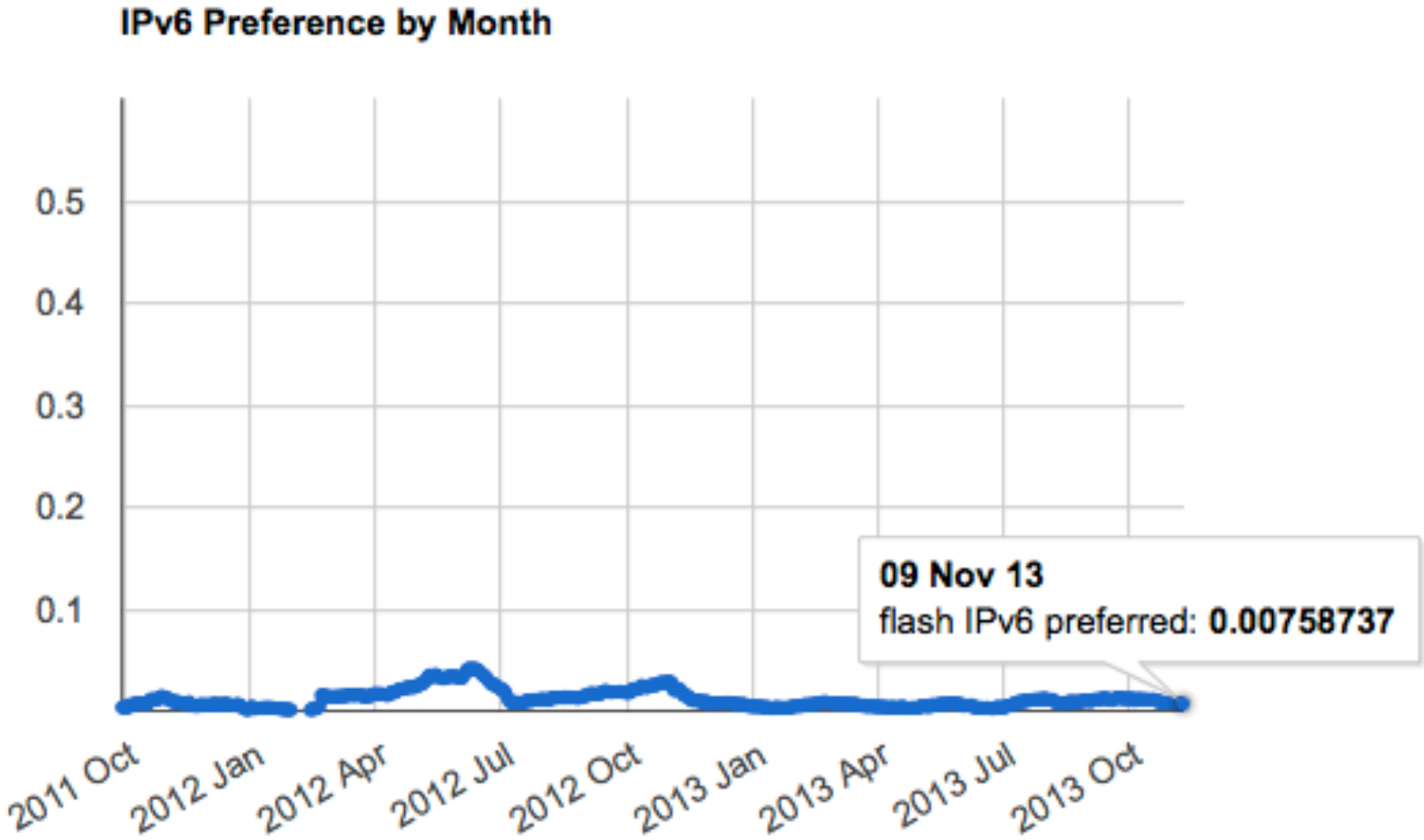
http://conference.apnic.net/__data/assets/pdf_file/0009/58455/ipv6-deployment-update-from-koreakisa_youngsun-la_1361361191.pdf

Korea

- IPv6 industry survey conducted by KISA (2013)
  - Relatively low response rate: level of interest toward IPv6?
  - Identified IPv6 challenges and requirements
    - Lack of experts and IPv6 technical knowledge
    - Lack of R&D test environment
    - Market's needs and government's plans
- Development of guideline document by the government
- Conducting performance measurement

http://conference.apnic.net/data/36/apnic36_nirsig_krnic_updateyoungsun-la_20130822_1377152839.pdf

Korea: Stats



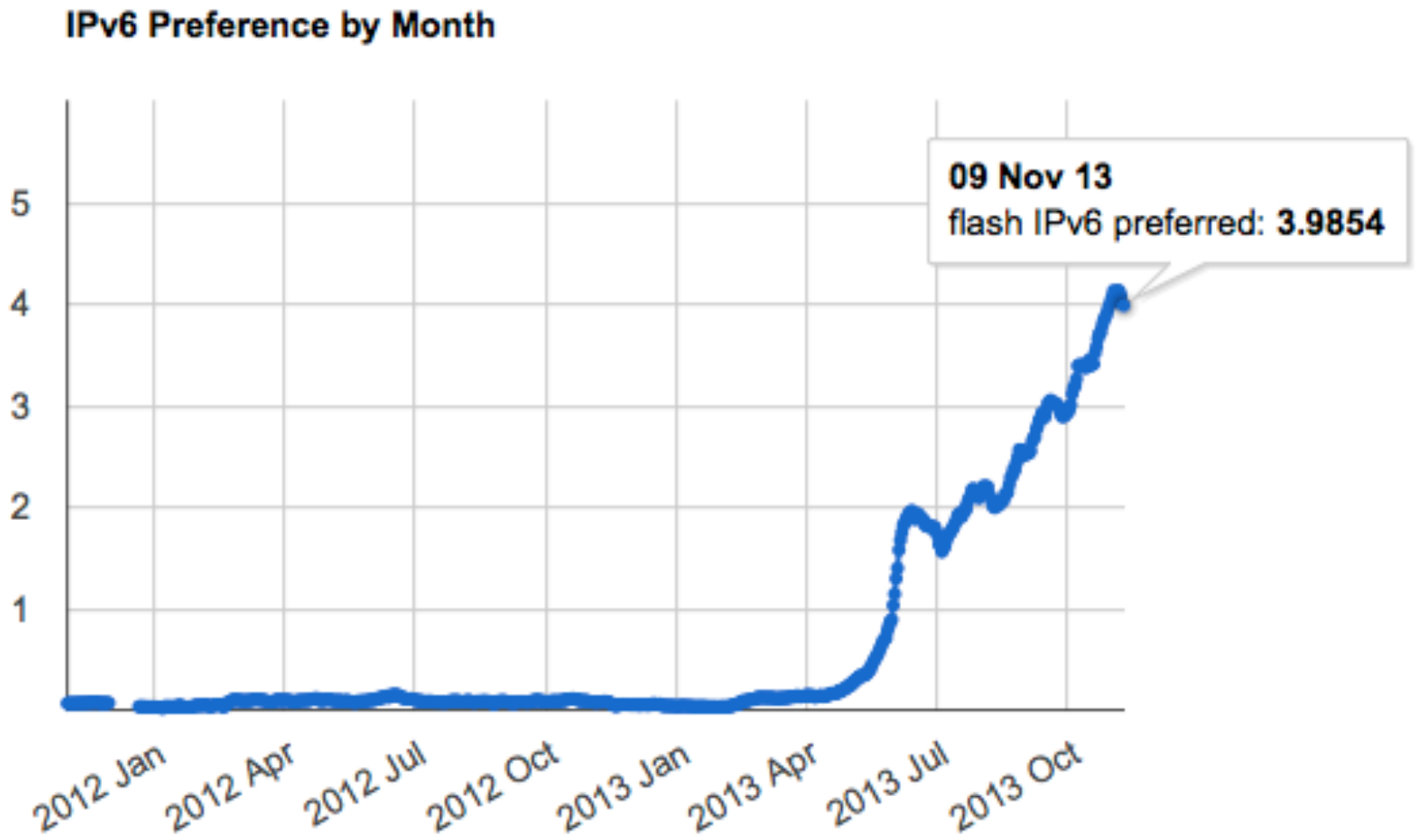
http://labs.apnic.net/ipv6-measurement/Economies/KR/

Singapore

- IPv6 Transition Program lead by Infocomm Development Authority (iDA) of Singapore
  - To apply multi-stakeholder approach in conjunction with “pull” and “push” strategies to support IPv6 adoption
    - Create Initial IPv6 demand by enterprises, government agencies, content and application providers
    - Create IPv6 supply by network providers
    - Drive competency across multi-stakeholders
    - Ensure IPv6 and IPv4 performance equity by hardware and software vendors
    - Raise awareness on IPv6 across multi-stakeholders
    - Managing IPv4 address exhaustion mainly by network providers
  - To address the issue of IPv4 exhaustion and to facilitate the smooth transition of the Singapore infocomm ecosystem to IPv6
  - To promote IPv6 adoption in the local industry
    - OneAsia Host, MobileOne, Starhub etc.

http://www.ida.gov.sg/Infocomm-Landscape/Technology/IPv6

Singapore: Stats



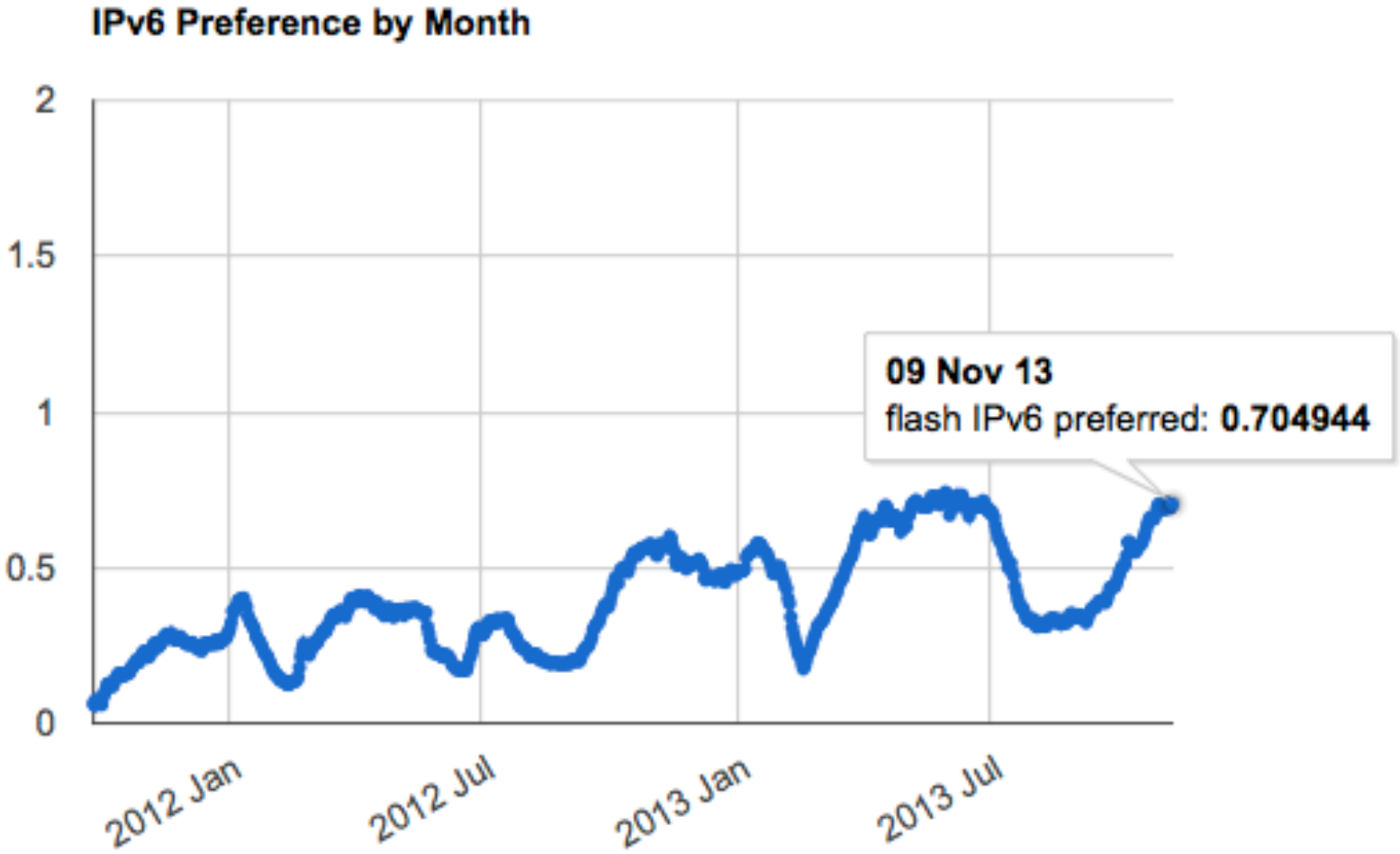
http://labs.apnic.net/ipv6-measurement/Economies/SG/

Taiwan

- “IPv6 Upgrade Promotion Program” lead by Ministry of Transportation and Communications
  - 2012 – 2013: Enable dual stack among 50% of public network services (Web, DNS, email)
  - 2014 – 2015: Enable dual stack the remaining public network services
  - Monitoring IPv6 deployment status in Taiwan
  - TWNIC’s active engagement

http://conference.apnic.net/36/program#/speaker/Sheng-Wei%20Kuo

Taiwan: Stats

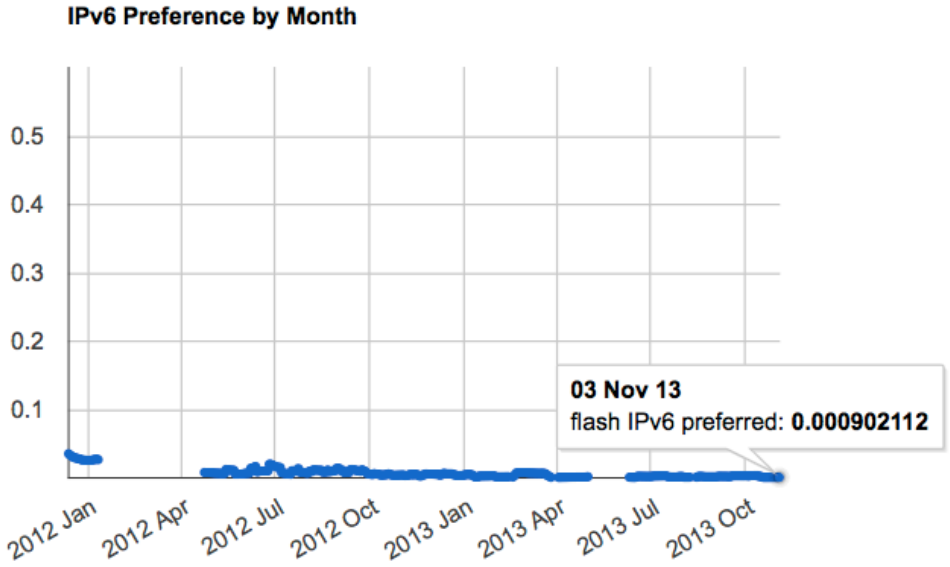


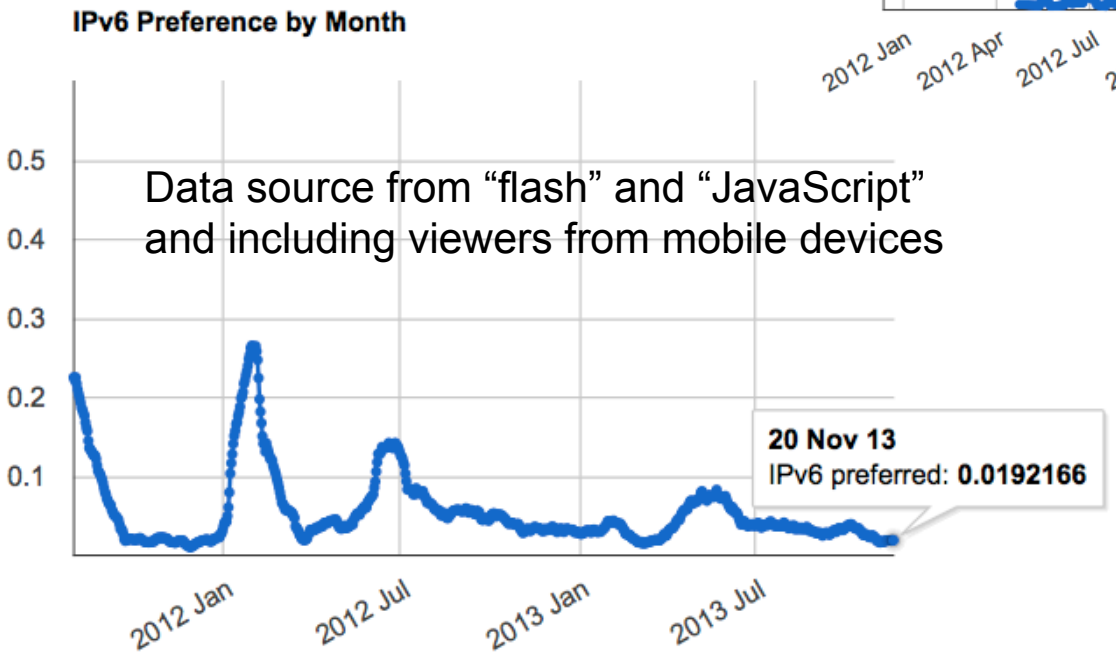
http://labs.apnic.net/ipv6-measurement/Economies/TW/

Vietnam

- Continuous support provided by Ministry of Information and Communications, Vietnam National IPv6 Task Force and VNNIC to raise IPv6 awareness and skill up trainings
  - Vietnam IPv6 Day Conference in 2012 and 2013
  - Vice Minister of MIC and CEOs of top 8 local ISPs officially launched IPv6 service, May 2013
  - IPv6 infrastructure security workshop for network engineers coordinated by VNNIC
    - Collaboration with JANOG members

Vietnam: Stats





Data source from “flash” and “JavaScript” and including viewers from mobile devices

http://labs.apnic.net/ipv6-measurement/Economies/VN/

Governments' support

- IPv6 awareness among governments' in the AP region is very high
  - Many initiatives from governments has been implemented
    - Partnership between the public and private sectors in various forms
    - Developing national policies and guidelines and roadmaps to enable IPv6
    - Enabling IPv6 in government networks
    - Mandating for IPv6 readiness in government procurement for ICT goods and services
    - Raising IPv6 awareness among key people in the government and industry
    - Providing timely skill up training
    - Monitoring IPv6 deployment measurement and share information with industry
    - Include the necessity of IPv6 deployment in ministerial statements
- Continuous engagement with industry will help

APEC TEL Ministerial Declarations

- APEC TEL: 21 member economies in the Pacific Rim
  - Brunei is an APEC member economy
  - ICT Ministers supported the APEC TEL IPv6 Guidelines in the 2010 and 2012 Ministerial Declarations
  - 2010: “We recognize that the free pool of IPv4 addresses is expected to be exhausted around 2012, and the transition to IPv6 will facilitate the achievement of universal broadband access in the APEC region. We support the IPv6 Guidelines developed by TEL.”
  - 2012: “Given the rapid growth of both fixed and mobile communication devices requiring unique Internet addresses in all member economies, we welcome TEL’s continuous efforts to progress transition to IPv6, as expressed in the TEL IPv6 Guidelines. We encourage TEL to cooperate with all stakeholders to achieve this goal.”

Preparation for the afternoon session

APNIC

Example: APEC TEL IPv6 Guidelines

- Scope of the document
  - Overall planning
  - Technical management
  - Human capacity development
  - International and cross-agency cooperation
  - Lead the industry by example by adopting IPv6
  - Partnership between governments and industry

http://www.apec.org/Groups/SOM-Steering-Committee-on-Economic-and-Technical-Cooperation/Working-Groups/~/media/Files/Groups/TEL/2010_APEC-TEL-IPv6-guidelines-FINAL.doc

Overall planning

- To review the impact of IPv4 address exhaustion
- To develop an IPv6 deployment plan
  - Deployment strategy
  - Scope
  - Schedule
  - Assessment
  - Public Relations (PR)
- Management and coexistence of IPv4
- Staff training
- To work with all relevant stakeholders

Technical management

- To assess the possibility of IPv4 and IPv6 co-existence with any desired technology to assure smooth transition from IPv4 to IPv6
- To assess IPv6 readiness of public ICT system
- To assess security implication of IPv6 deployment and adjust your security plans appropriately
- To work as appropriate with groups (e.g., APNIC) to further your technical capacity
- To identify existing test labs in the APEC region and develop plans for information exchange and cooperation
- To promote information exchange and cooperation between existing test labs in the region and other relevant groups (e.g., APEC TEL)

Human capacity development

- To work with experts from the private sector, the Internet technical community, and academic institutions to enhance IPv6 skills of technical staff in relevant entities
  - Regular skill up trainings and workshops
  - Establishing a test lab
- To monitor development of IPv6 Best Current Practices (BCP)
  - Network Operators Group meetings
  - Asia Pacific Regional Internet Conference on Operational Technologies (APRICOT)

International and Cross-Agency Cooperation

- To share information and BCP of IPv6 deployment with other economies via inter-governmental organizations, e.g.,
  - APEC TEL, APT, ITU, etc.
- To encourage information exchange and sharing among agencies and ministries in order to establish best practices and to avoid duplicating efforts in each IPv6 implementation

Lead the industry by example in adopting IPv6

- To ensure governments' online presence is accessible by both IPv4 and IPv6
- To work with relevant government agencies to advise new procurement requirements to include IPv6 capabilities

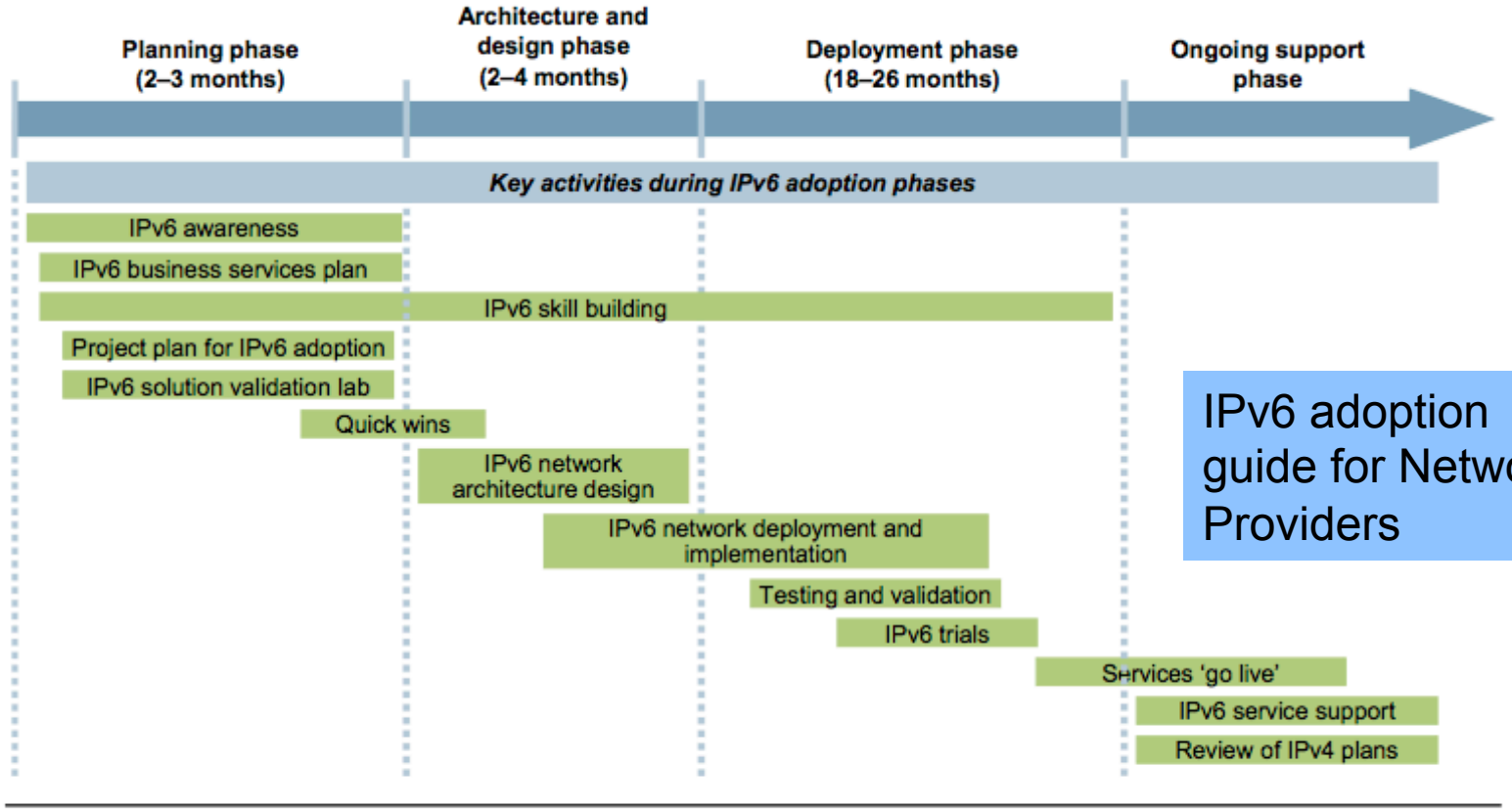
Partnership between governments and industry

- To conduct periodic information exchange and other collaboration initiatives with the industry on Ipv6 deployment plans

Example: Singapore

- Report for Infocomm Development Authority (iDA), “IPv6 adoption guide for Singapore” by Analysys Mason and Tech Mahindra
  - http://www.ida.gov.sg/~/media/Images/Infocomm%20Landscape/Technology/IPv6/download/IPv6AdoptionGuideforSingapore.pdf
- Thorough survey to identify the current status of IPv6 in Singapore
- Develop IPv6 adoption guidelines

Example: Singapore



IPv6 adoption guide for Network Providers

Figure 6.1: Activities involved in the four IPv6 adoption phases for network providers [Source: Analysys Mason, Tech Mahindra]

http://www.ida.gov.sg/~/media/Images/Infocomm%20Landscape/Technology/IPv6/download/IPv6AdoptionGuideforSingapore.pdf P56

Example: Taiwan

- National IPv6 Program
  - Taiwan IPv6 UP Program initiated by National Information and Communication Initiative Committee (NICI)
  - Phase 1: 2002 – 2008, Study
  - Phase 2: 2009 – 2012, Pre-implementation
  - Phase 3: 2012 – 2016, Upgrade Program

http://conference.apnic.net/__data/assets/pdf_file/0016/50650/taiwan_ipv6_success_story_new0822_22p_1346233359.pdf

Example: Taiwan

- Goals
  - Upgrade Government Service Network (GSN) to IPv6 smoothly
  - Encourage R&D of IPv6 enabled appliances and services
  - Encourage creation of intelligent IPv6 applications
- Strategies
  - Conduct a survey to identify challenges
  - Define Standard Operating Procedure (SOP) to enable IPv6 services for major Internet services
  - Encourage ISPs to deploy IPv6 transition technologies
  - Support technical IPv6 training courses

http://conference.apnic.net/__data/assets/pdf_file/0016/50650/taiwan_ipv6_success_story_new0822_22p_1346233359.pdf

Example: Taiwan

- Government's IPv6 transition initiative:
  - Good approach to motivate the ICT industry to develop IPv6 services
- Cost effective strategies
  - To upgrade in accordance with the age-replacement of network devices
- Monitoring IPv6 deployment status
  - IPv6 allocation and BGP advertisement
  - IPv6 enabled end users
  - Network traffic
  - Services availability of ccTLD
  - DNS query to specific ccTLD
  - Number of IPv6 enabled products

Discussion in the afternoon

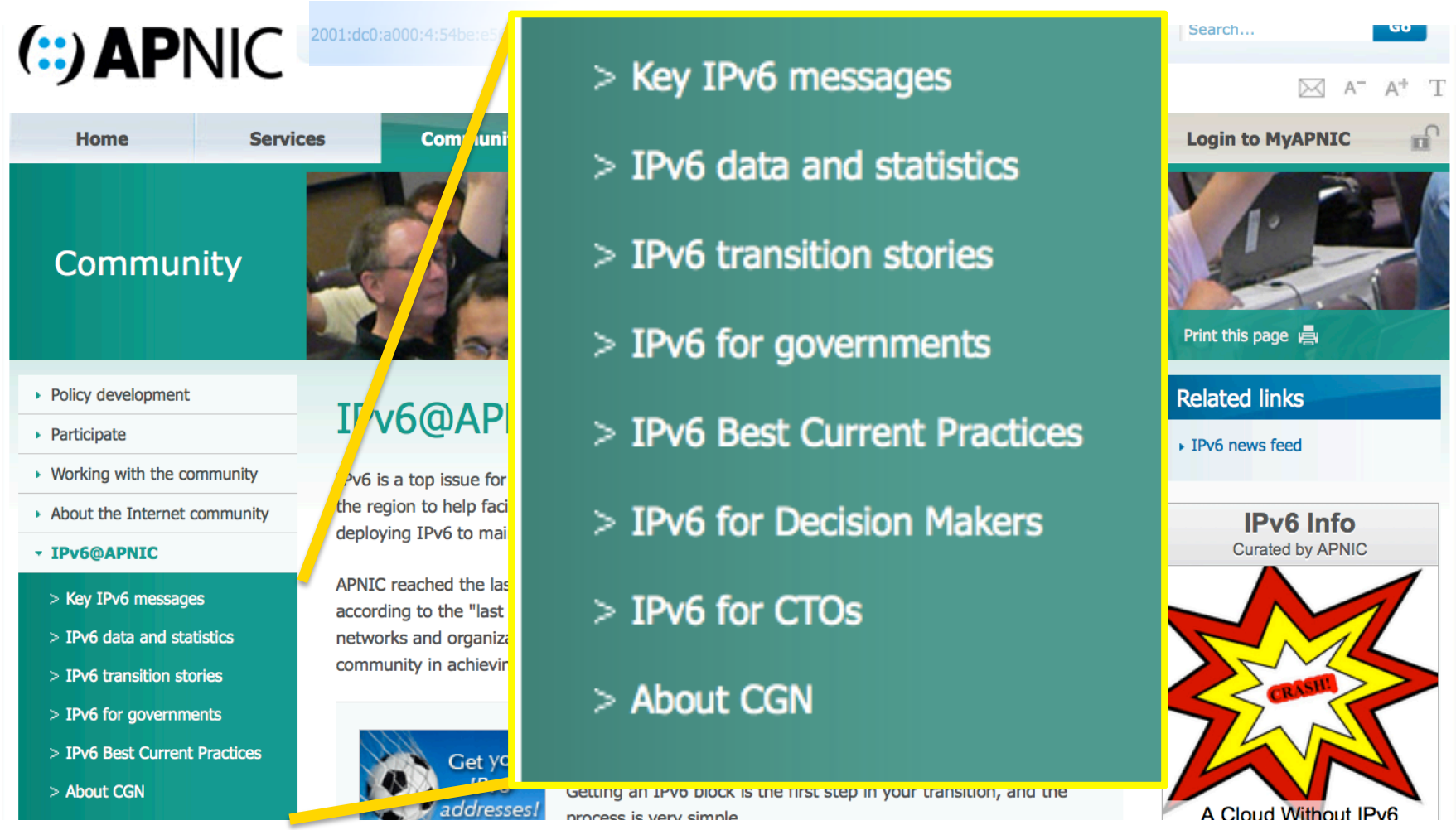
- Does Brunei need to care about IPv6?
  - If so then why?
- How does Brunei want to mange the IPv6 transition process?
- What will work for Brunei?
  - Is there any good example already existing?
- What are your timeframe?
- Etc.

Useful resources

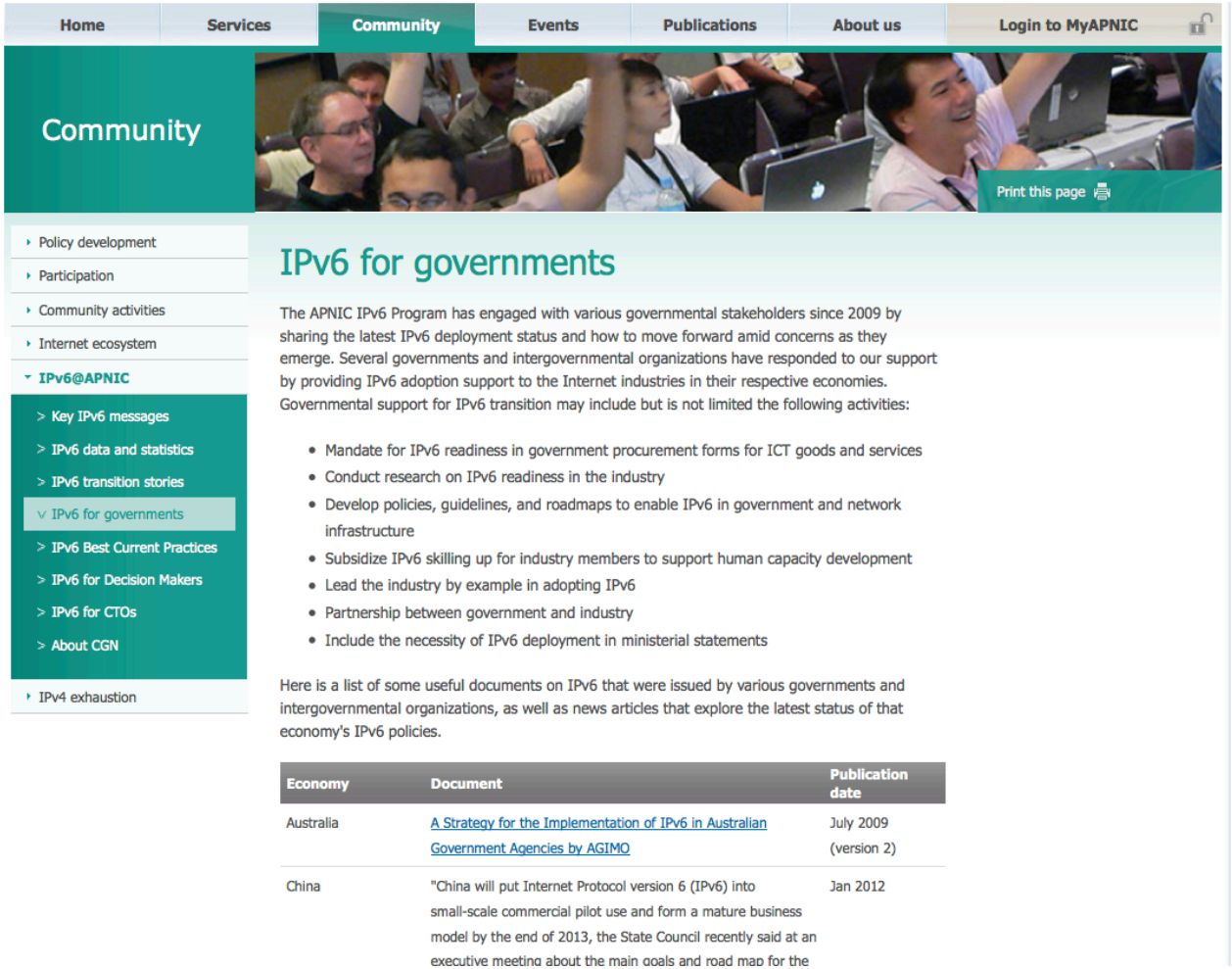
APNIC

www.apnic.net/ipv6

www.apnic.net/ipv6

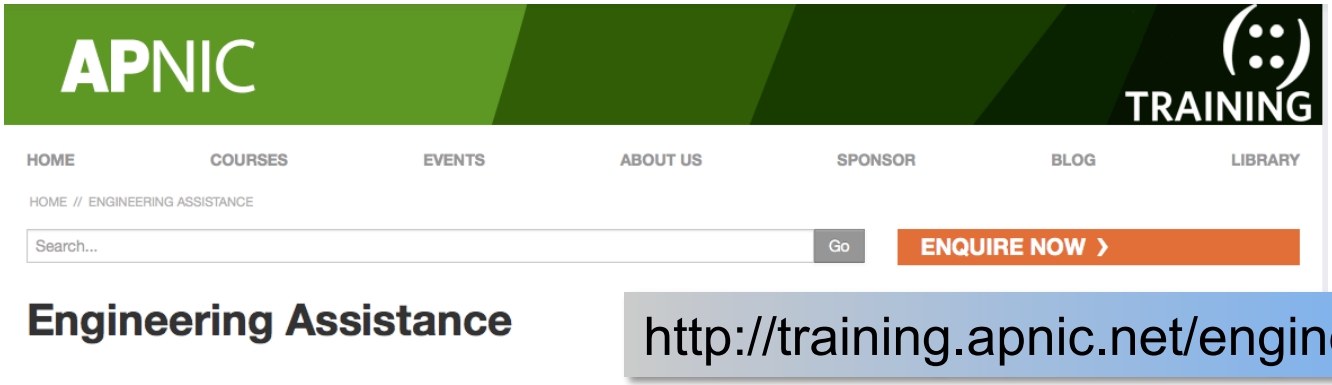


IPv6@APNIC: IPv6 for governments



APNIC trainings

APNIC engineering assistance



http://training.apnic.net/engineering-assistance

- Directly support regional infrastructure development
- Bridge the gap between APNIC Training courses and the services of a consultancy organization
- Cost recovery
- Specialist skills
  - Routing protocols, IPv6 technology and deployment, Network infrastructure security etc.

APRICOT2014 and APNIC37 Feb 2014

http://2014.apricot.net/program

Thank you!

APNIC